

Illuminating Engineer

VIII.

August, 1935

Price 9

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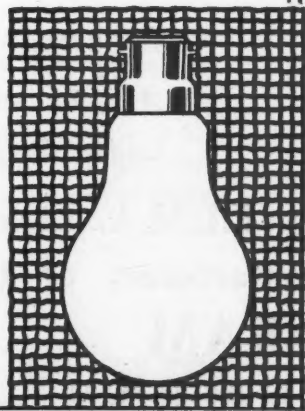
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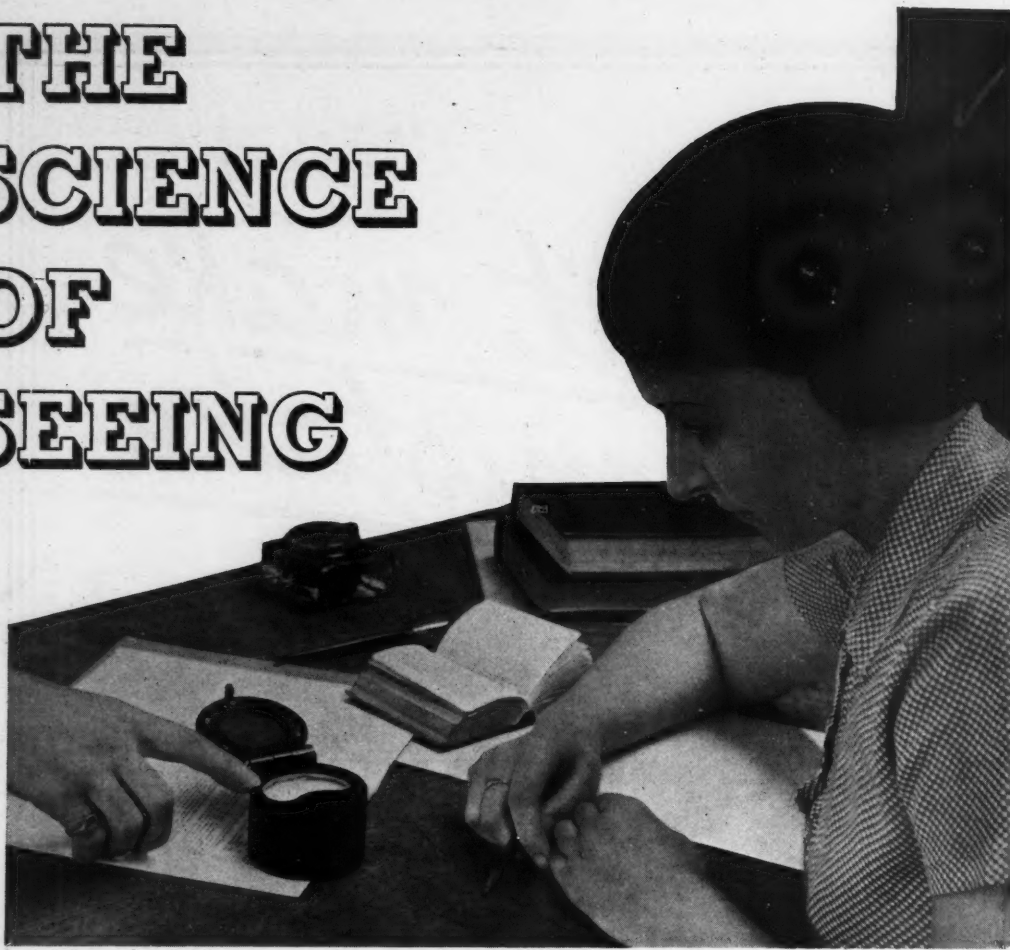
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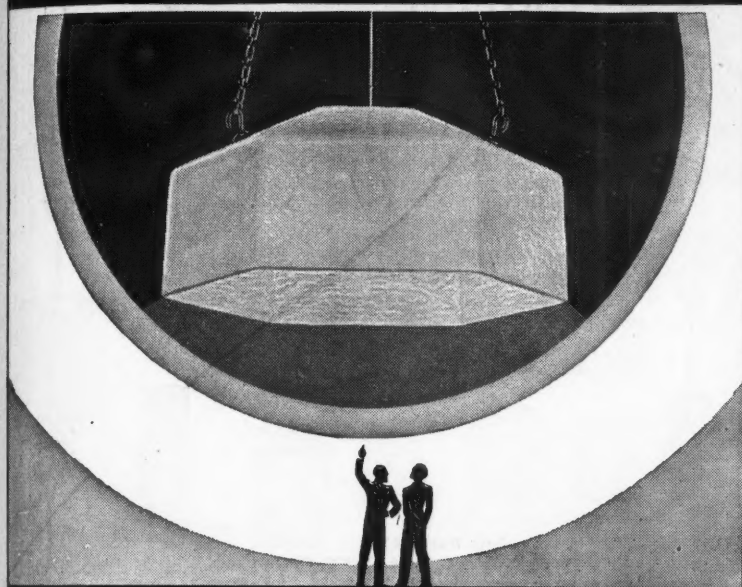
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An illustration for a Siemens Electric Lamps advertisement. At the top, the word "SIEMENS" is written in large, bold, stylized capital letters, with "ELECTRIC LAMPS" in smaller, bold capital letters below it. To the right of the central image, the text "Used for lighting Big Ben and just as Reliable." is written in a cursive script. The central image shows a woman in a dark dress pointing towards a large, detailed illustration of Big Ben. A young boy is kneeling on the left, looking up at the clock tower. A young girl is sitting on the right, looking up at the clock tower. The background is dark, suggesting a night scene. In the bottom right corner, there is a circular logo with the words "BRITISH MADE" inside.

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The Needs of Pedestrians

At the recent Conference of the Institution of Municipal Engineers in Folkestone, Mr. R. G. Narbeth (Deputy Engineer and Surveyor, Barnet U.D.C.) drew attention to certain needs of pedestrians in busy streets. Traffic signals, which have proved of great benefit to the pedestrian, are, nevertheless, addressed primarily to drivers of vehicles, and are so arranged as to be readily visible to them. He suggested that a clear signal to pedestrians, preferably at eye-level, was desirable. As electric signals can be readily exhibited simultaneously at different points, the installation of a few additional duplicate ones for the benefit of pedestrians should not prove unduly difficult or expensive. Other suggestions by Mr. Narbeth were that pedestrian crossings should be more clearly defined by the use of coloured concrete, black and white paving, etc., and that special lighting (such as is already customary in Paris), e.g., a beam of light effectively floodlighting the whole width of the crossing, should be provided. It is also suggested that every road bearing an appreciable volume of foot-traffic should have a footway, adequately surfaced, or at least one level grass verge, as a refuge for pedestrians. Mr. Narbeth emphasised the value of good street-lighting in preventing accidents, and contended that in built-up areas all classified roads and traffic routes should be lighted sufficiently well to make the use of headlights unnecessary. He remarks, however, that street-lighting on main roads in rural areas "is impracticable on financial grounds, and would in any case be objectionable aesthetically"—a view which would certainly be contested by many of those interested in public lighting! His further remark that whitened kerbs are of great assistance to motorists, and his suggestion that guide lights should be set in the kerb at frequent intervals (or reflectors similarly fixed), as an aid during fogs, deserve consideration, though, fortunately, dense fogs are sufficiently infrequent nowadays to render the installation of a permanent system of "fog lighting" a doubtful proposition.

The Importance of Kinematical Factors in Roadway Illumination

We regret that by an oversight the name of one of the authors of the above paper, which is to be read at the twelfth annual meeting of the Association of Public Lighting Engineers in September next, was omitted in the notice which appeared in our last issue (p. 235). The paper is to be presented by Mr. R. Maxted and Mr. L. J. Davies, both of whom are associated with the B.T.H. Research Laboratory at Rugby.

Domestic Lighting

Opticians ought surely to be interested in artificial lighting, on the use of which the welfare of the eyes so greatly depends. One is therefore pleased to note that in "The Journal of Vision," Mr. Boatman has included a contribution on the "Lighting of the Home." This follows familiar lines in discussing the requirements of different types of rooms, and in emphasising the needs of certain parts that do not always receive the attention they merit, such as the bathroom, kitchen, scullery, and cellar. One point that should be recognised is the uses to which living rooms are put vary much from time to time. They may, for instance, serve for serious study (in which case the best possible illumination for reading purposes should be available), or for actively entertaining guests, in which case moderately high general lighting may be needed, or merely for desultory reading and quiet conversation, when subdued illumination, assisted by well-shaded local lamps, would meet the case. These varied conditions can all be met in the same room by the elasticity of modern lighting equipment. The great point is that the householder should not scrimp himself in equipment, but should, at the very start, arrange sufficient outlets to make possible any form of lighting that he is likely to require. The article also refers to several subsidiary forms of domestic lighting, such as lighting of the garage and garden, and the illumination of the name and number of the house. If it is still true to-day that the Englishman's home is his castle, he is not usually concerned to conceal his domicile from enemies, and ought to make it reasonably recognisable to friends.

Public Lighting in Bombay

We recently had the pleasure of meeting Mr. J. P. Blackmore, Lighting Superintendent to the Bombay Gas Company, who is on leave in this country and hopes to attend the Conference in September next. In his paper presented at the A.P.L.E. Conference in Margate in 1933, Mr. Blackmore gave some account of the special problems met with in that city. We were interested to hear at first hand, something further of these troubles—more especially those in connection with the racial riots and disturbances of a few years ago; one could only wonder at the tenacity of the officers of the company in preserving any street-lighting at all in such circumstances! One pleasing feature in Bombay, however, is the friendly relation existing between those responsible for the gas and electric lighting, who quite frequently do each other a service, and who meet in keen and friendly rivalry on the cricket field at least once a year!

The Production of Light

by M. PIRANI (Berlin)

(Address delivered at the Annual General Meeting of the Illuminating Engineering Society, held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, at 6.30 p.m., on Tuesday, May 14th, 1935.)

Mr. President, ladies and gentlemen, fellow-members of the Illuminating Engineering Society, I feel greatly honoured to have the opportunity of giving this address containing an informal account of some conceptions bearing on the production of light, in which I have been engaged during the last few years.

Introduction.

The ideas which I intend to submit in the first part of my address are somewhat theoretical. Yet they have a certain practical value, since progress, as I understand it, always involves a vigorous programme of research, and this again is inseparable from a clear perspective on the scientific foundations.

As an illustration of some of the theoretical points, and at the same time in order to indicate methods of demonstrating these physical theories, I should like to show you some experiments which I recently devised, and which deal especially with the phenomena of fluorescence and phosphorescence.

In the second part of my address, which will lead to practical questions, I want to deal with a problem of importance for every technique, namely, with the "energy balance." The question where, in a technical process, the energy is dissipated is not only of technical and scientific importance, but is, perhaps, even more of economical interest. This is particularly true and important in the case of illuminating engineering, on account of the very poor output which we have hitherto obtained from our illuminants.

This poor output, as you know, has correctly been attributed to a natural law, which governs the visual efficiency of the radiation coming from incandescent bodies. Now—and this has a very close connection with the theoretical exposition which I will give in the first part of my address—these laws do not hold at all for other methods of light-production. We can hope to get gradually increased efficiencies if we use more and more of these other methods, which do not depend on incandescence and are illustrated especially in the now familiar electric discharge lamps. In the third part of my address dealing with modern practical applications of gas discharge, I will give you some details of the technical properties of the gas discharge lamps as used at present on the Continent, especially in Germany. Then I shall try to give a short account of some new types of special lamps for different purposes, and to review the application of discharge lamps in illuminating engineering practice.

Coming now to the subject of my lecture, I must first of all apologise for two things. First, for my poor knowledge of your language, which unfortunately I cannot overcome in spite of the kind help of my kind friends of the G.E.C., and, secondly, for my rather academic lines of thought which are based on the kind of work I have been doing in the last thirty years.

Theory of Light Production.

Our knowledge of the radiating properties of atoms and molecules in a gaseous state has created a new foundation for the investigation of the fundamental processes of light production.

Any mode of production of light, that is to say, method of producing electro-magnetic radiation, is

based on the existence of mutual electrical reactions of structural elements, which might be likened to the aerial in a short-wave transmitter. These reactions take place:—

- (1) If electrical charges are moving periodically.
- (2) If sudden changes of speed of electrically charged particles take place.

The systems, which are able to perform periodical movements, have certain resonance frequencies. Whether these frequencies come into action during the emission depends, firstly, upon the coupling of the system with its neighbouring systems, and, secondly, upon the nature of the excitation.

The example of radiation without coupling is found in a single atom. The basic or resonance vibration, which appears in the spectroscopy as the *resonance line*, may be excited by absorption of this frequency, or by impact of electrons of a given speed; just as it is possible to excite a freely vibrating cord to perform its resonance vibrations.

Atoms in a nearly isolated state are to be found in highly rarefied gases. One gets the resonance line either by absorption of the resonance radiation or by impact of electrons of sufficient speed.

The spectrum of a diatomic gas can be theoretically developed from the spectrum of a monoatomic gas on the assumption that every line is split up by the mutual vibrations of the nuclei into a system of bands. If one tries to excite the resonance spectrum of such a gas by monochromatic light or by electron impact, one gets the emission of a series of lines instead of a single line. If one takes less rarefied gases for this experiment, one gets diffuse lines in consequence of the mutual reaction of the atoms. This diffusion may reach quite considerable values as the pressures get higher and higher.

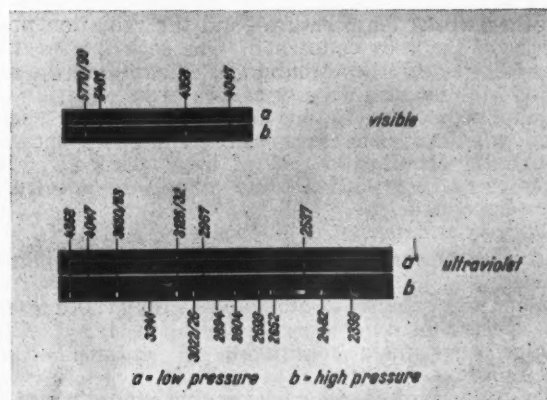


Fig. 1 Spectra of low and high pressure mercury discharges.

Fig. 1. shows the development of a spectrum with increasing pressure. A further "filling up of the spectrum," as one might term it, takes place if, with high excitation, the concentration of atoms and ions gets so high that these come in close contact with the light quanta and electrons. As a consequence of a high concentration of ions, which causes an increas-

ing opportunity for the recombination of ions and electrons to neutral atoms, we find sections of continuous radiation in the spectra.

Kind of energy	Isolated atoms Density: 10^{12} – 10^{20} cm ⁻³	Interaction of atoms 10^{12} – 10^{20}	Liquids 10^{23}	Cryst. solids 10^{23}	Metals 10^{23}
Selective excitation	1) Electron impact, definite min. Speed.	Frank-Hertz lamps-Hg	lamps-Hg, N ⁺	—	Cathode-fluorescence and phosphorescence
	2) Impact of heavy particles	cf 1)	—	cf 1)	Radioactive paints
	3) Energy transfer by resonance	Smeltized fluorescence Hg-Tl	Smeltized fluorescence	—	—
	4) Photons	Fluorescence in the space No-vapour	Fluorescence on the surface multi-metal/glass/fluoresceine	Fluorescence fluorescence and phosphorescence ZnS	—
Statistical distribution of excitation	Processes 1)–4) Simultaneously	Thermic excitation No-flame	Thermic excitation lamps-Hg multi-metal/glass/fluoresceine	Thermic excitation Thermic excitation Normal glow	Thermic excitation Incandescent lamps arcs

Table I. The possibilities of excitation of light.

Table I. shows the various processes by which light may be produced.

The first column gives the different kinds of energy input—(1) electron impact; (2) the impact of heavy particles, for example, ions or alpha particles; (3) energy transfer by resonance, which takes place very often by chemical processes. These lead mostly to fluorescences of different kinds. Well-known examples of this type are the fluorescence of the firefly or of decomposing wood; (4) excitation by photons, which might be called materialised radiations. In the case of thermic excitation we have a combination of several kinds of excitation.

In the first horizontal row in Table I. we find the order of magnitude of the atomic densities per cubic cm.

The Table shows all our well-known sources of light-production: the processes occurring in the electric discharge lamps appear in the uppermost section to the left, those characteristic of incandescent lamps in the lowest section to the right: methods associated with luminescent arcs as well as the radioactive paints and the firefly are also illustrated.

I shall now say a few words on the radiation of concentrated matter in temperature equilibrium.

Different Forms of Spectra.

The emitted radiation in this case is distributed over all possible frequencies of the system, following laws, which are controlled by the energy-content—in other words temperature—and the radiation properties of the body concerned. One gets line spectra on a faint continuous ground, for example, in the so-called high current density carbon arcs.

Solid bodies and liquids have a continuous spectrum, which in some cases (e.g. with carbon) show a distribution similar to that of the black body. In other cases (e.g. with Erbium oxide) the spectrum has a band structure.

We may summarise as follows:—

Isolated atoms give relatively simple regular line spectra.

When the packing of atoms gets gradually denser, the spectra become more complicated and finally change over to a continuum of statistical constitution.*

The one limit is reached by the excitation of a resonance line, the other by the temperature radiation of the non-selective solid body, which follows approximately the laws of black body radiation.

Phosphorescence and Fluorescence.

Next, in the central portion of Table I. we find fluorescence and phosphorescence phenomena. Though in general the mutual coupling of the mole-

cules in matter of great density is so intense, that it is impossible to excite a single frequency, this can be done in rare cases, where an atom or a molecule capable of radiating is situated in such a protected position that it can vibrate without interfering with the surrounding molecules. In such circumstances a given frequency band may be absorbed and re-emitted by this molecule. Such radiations are termed "fluorescent."

Among the fluorescent liquids are such organic compounds as fluoresceine, eosine, rhodamine. There also exist some crystalline solid bodies, in which the atom is protected in the manner I have just described so as to be capable of undisturbed radiations. In another group of solids, the so-called phosphorescent bodies, the radiating systems have separated centres for absorption and emission.

These substances are activated by heterogeneous molecules, which are found in a proportion of 1 to 100,000 of the original body—for example, 1 molecule of copper in 100,000 mol. of zinc sulphide. Such inhomogeneous lattices are capable of storing energy as I will show by experiment.*

The stored energy can be transferred to the activating atom, which itself is then excited to radiation. The mechanism by which this is done is not perfectly known, but it is certain that the temperature vibrations of the molecules play a part in this event. We learn this from the fact that phosphorescence depends upon temperature.

The emission process is quickly extinguished in fluorescent matter and slowly extinguished in phosphorescent bodies. The maxima of excitation and emission are always separated in phosphorescent bodies and are often fairly remote from each other.

As an example, let us examine the differing condition of the exciting radiation with different phosphorescent substances as shown in Fig. 2.

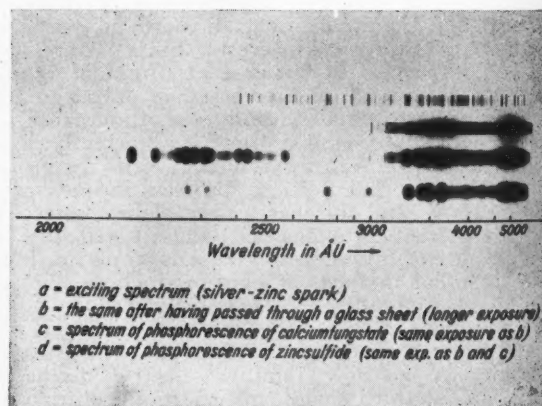


Fig. 2. Fluorescence and Phosphorescence.

Here (a) shows the exciting spectrum (Ag-Zn spark).

(b) Shows the same taken with a glass plate placed on top of the emulsion, thus absorbing the ultra-violet radiation.

(c) Shows the result obtained by coating the side of the glass plate remote from the emulsion with calcium tungstate, the visible phosphorescence of which passes through the glass plate and registers on the photographic emulsion in the position of the radiation which excites it.

(d) Shows the same thing with zinc sulphide.

We can see clearly the position of the phosphorescence maxima of calcium-tungstate and zinc sulphide.† The activated centres of phosphorescent substances can also be excited by high-speed electrons, or by the impact of heavy particles. We are

* "Die Naturwiss" (23), Vol. 25, June 21, 1935.

* "Das Licht," pp. 93-98. (1935.)

† "Zeitschr. für techn. Phys." 14, pp. 31-32. (1933.)

familiar with this in the phosphorescent screens used in television and for radio-active paints.

I should like to show you now some experiments on fluorescence and phosphorescence.

(1) *Firstly* note the difference between these two kinds of substances:—

- (a) Uranium glass, fluoresceine, rhodamine are *fluorescent*. You do not see any after-glow after they have been excited, e.g., by the u.v. radiation of a mercury lamp.
- (b) Zinc-sulphides of different colours are *phosphorescent*, the after-glow is very marked.

(2) *Secondly*, I would ask you to note two important laws:—

- (a) The colour of fluorescence is practically independent of the exciting radiation.
- (b) The exciting wavelength must always be shorter than the emitted one. (Law of Stokes.)

I have here in this box six light sources of radiation yielding: (1) ultra violet, (2) blue, (3) blue-green, (4) green, (5) yellow, and (6) red light.

I expose an opalescent solution to the radiations of these light sources, and you see that the solution scatters the light and shows the colour of the lamp. When exposed to the ultra violet radiation it remains dark. Now I expose a fluoresceine solution to the different radiations, and you see that it shows a green luminescence in the ultra violet radiation. It does not change its colour when excited by different wave-lengths. In the light of the yellow and red lamp it remains dark, because the maximum wave-length of the emitted light is in the green part of the spectrum. We see, therefore, that it is only excited by shorter wave-lengths. I may add that the theoretical maximum efficiency of such an excitation of fluorescence is given by the ratio between the wave-lengths of the exciting and the emitted light. Thus it is 0.5 when a fluorescent substance is excited by the ultra-violet resonance line of mercury 2537 Å., and emits green light of wave-length 5074 Å.

(3) *Thirdly*, I would ask you to note the difference between two paints. These have nearly the same colour in the light of an incandescent lamp, but by bringing them into monochromatic illumination they differ in colour. The one is a rhodamine paint as used sometimes in street signs. It is excitable by all wavelengths below the yellow, but not by red, whilst the normal red paint does not show any colour, as the incident light contains no red radiation.

(4) *Fourthly*, I want to show the influence of molecular temperature vibrations on the phosphorescence.

I first irradiate the substance with ultra-violet light. You see the after-glow. Now I put it into liquid air, which weakens the temperature vibrations of the molecules. The afterglow disappears. But the radiating energy is not abolished. The emission has only been stopped. The energy is stored in the phosphorescent body. As soon as it gets warm enough it recommences to emit light, until it has emitted all the absorbed energy. This is, as you see, a kind of saving box for light.

(5) *Fifthly*, I will show you now a practical use of fluorescent substances in electric discharge tubes for advertising purposes. The glass tubing is coated inside with zinc-sulphides of different fluorescent colours. These are excited by the ultra-violet and blue radiations of the mercury discharge which strike them directly. This tubing is made by the Claude-Gen Company, who kindly placed it at my disposal. Similar kinds of tubes are in fairly wide use on the Continent, and their number is rapidly increasing, because of the great variety of colours one can produce by this method.

(6) *Sixthly*, I wish to show the excitation of light by impact of alpha particles. I have here a glass cylinder with a fluorescent powder, and I pour into

the cylinder a radio-active solution, which I obtained from the Auergesellschaft in Berlin. You see the whole cylinder glowing with a faint light. This is the method of making auto-fluorescent colours, which are used in watches, indicators for electric switches and so on.

There is a rather peculiar application, which nature has made of fluorescence in the so-called "buckwheat" disease of cattle. It is known to the farmers of some countries that light-coloured pigs having eaten buckwheat plants on the meadow must be kept in a dark stable for some hours, because, if exposed to light immediately after the meal, they get bad inflammations of the skin, which leads sometimes to death. It has been found that this was caused by the formation of a fluorescent substance in the skin. The ultra-violet radiation in sunlight by the transfer of light energy may cause fatal disturbances of biological functions. Dark pigs, however, whose hairs absorb ultra-violet energy, are not subjected to these dangers.

Efficiencies of Illuminants.

Returning now to the main subject of my lecture, I should like to speak of the efficiencies of our light sources, and especially of the possibilities of getting good efficiencies. Recalling the different methods of light production assembled in Table I., let us try to single out those that are most efficient. As this is not a purely technical problem, but mainly a physiological one, we have to consider it in relation to the luminosity curve of the human eye.

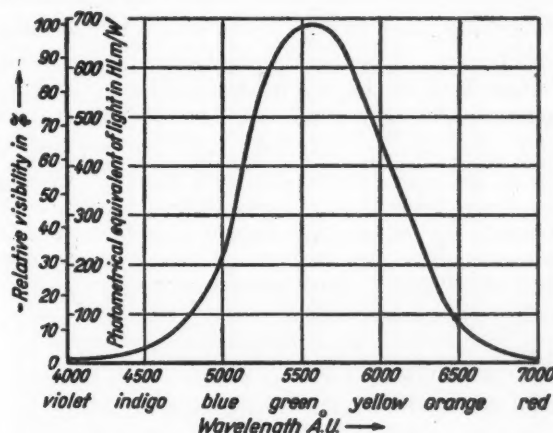


Fig. 3. Standard visibility curve and photometric equivalent of light for different wavelengths.

Fig. 3 shows the maximum efficiencies which we can attain by means of monochromatic light-sources, emitting their individual wavelength with 100 per cent. energy output and an illumination of, say, 10 ft. candles. They are very high at the maximum of the luminosity curve in the neighbourhood of 5,500 Å. (green) where the curve shows 693 $\frac{\text{Hefner Lm}}{\text{W}}$ or 624 $\frac{\text{"International" Lm}}{\text{W}}$. It decreases rapidly on both sides, being 10 per cent. of that value at 4,700 and 6,500. We call these efficiency figures the "photometric equivalents of radiation."

Now, our familiar incandescent lamps, as we know, are very uneconomical, because they give less than 25 Lm/W. Could they not be greatly improved?

We must first consider how to calculate the maximum efficiency of a light source. We realise that this value must depend greatly on the distribution of the energy of the source through the spectrum. Having measured this distribution for the wavelength of visible radiation, we have to multiply these values by the relative luminosity values $J_{\lambda} \cdot V_{\lambda}$.

The sum of the products thus calculated for all wavelengths, divided by the total intensity, gives

a proper fraction, which represents the maximum photometric equivalent of radiation we can possibly reach with the light source concerned.

Sodium vapour pressure $5 \cdot 10^{-2}$ mm, current density 1 A cm^2 , rare gas filling: a few millimeters of Ne		
Wavelength A.U.	Spectral intensity J_λ	Spectral luminosity $J_\lambda \cdot V_\lambda$ ($V_\lambda = \text{visibility}$)
71404 - 382	10	0,0
6795 - 83	19	0,0
6161 - 54	0,3	0,13
5896 - 90	100	76,50
5888 - 83	1,2	1,15
5154 - 49	0,1	0,06
4983 - 79	0,2	0,05
$\Sigma J_\lambda = 130,8$ $\Sigma J_\lambda \cdot V_\lambda = 77,90$ $\frac{\Sigma J_\lambda \cdot V_\lambda}{\Sigma J_\lambda} = 0,595$ Luminous efficiency for the radiation from the pos.col.: $\frac{0,595}{0,00145} = 410 \text{ HLM/W.}$		

Table II. Relative spectral intensities and spectral luminosity values of series lines in the positive column of a sodium lamp.

Table II. shows how this calculation is to be made in the case of the radiation of the positive column of a sodium vapour lamp. If we could devise suitable practical conditions, we could reach $0.595 \times 693 \frac{\text{HLM}}{\text{W}}$ or $410 \frac{\text{HLM}}{\text{W}}$.

Applying this calculation to a black body radiation, we can only reach $96 \frac{\text{HLM}}{\text{W}}$ even with a temperature of $6,500^\circ \text{ abs.}$ —a temperature which is not possible to attain with any known terrestrial body. Since the maximum efficiency drops rapidly with temperature and is only $21 \frac{\text{HLM}}{\text{W}}$ at $3,000^\circ \text{ abs.}$, we can hardly hope to get much better efficiency than we already have from approximate non-selective incandescent radiators. So you see that we are more interested in the electric discharge because of their more favourable energy distribution through the spectrum.

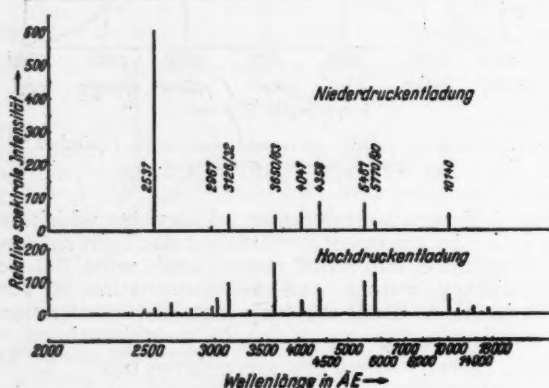


Fig. 4. Spectral energy distribution of low and high pressure mercury discharges.

Fig. 4 shows schematically the energy distribution of a low-pressure mercury discharge of 1.0 mm. vapour pressure, and that of a high-pressure column of some hundred mm. pressure. Both discharges are set to the same total energy radiation.

We see at once why the low-pressure discharge has a poorer light efficiency than the high-pressure discharge. It is because the ultra-violet radiation with low pressure is much greater and the lines in

which the luminosities have high values are relatively faint. We can also realise from this diagram that the use of phosphorescent and fluorescent substances in connection with low-pressure mercury discharge will lead to a good efficiency, if the fluorescent substances can be excited by the resonance line and will emit the absorbed energy in form of visible light especially in the green and yellow part of the spectrum. On the other hand one finds that the problem of using fluorescence and phosphorescence is complicated by other variables.

I have calculated some of the optimum theoretical efficiencies of gas discharges and have arrived at the following figures:—

Sodium 410 HLM/W; Mercury (high press.) 150 HLM/W;
Cadmium 45 HLM/W
Neon 149 HLM/W; Mercury (low press.) 73 HLM/W;
Zinc 45 HLM/W

But, unfortunately, efficiencies realised in laboratory-made experimental lamps are in HLM./W.:—

Sodium, 120; Neon, 30; Mercury (high-pressure), 60; Mercury (low-pressure), 25; Cadmium, 5; Zinc, 3.

How does it come that with practicable lamps we are so far away from the optimum values?

It is because by exciting an atom by electron impact under practical conditions, a great deal of the energy is dissipated by diffusion of the electrons to the walls, where they release their energy in the form of heat. In practical vapour discharge lamps (sodium and mercury high pressure) this loss actually is desirable, because only by the higher temperature of the walls the vapour pressure is sufficient for the functioning of the lamp.

Source	Neon-discharge tube Diam: 2 cm, Length: 34 cm Gas pressure: 3 mm Hg Sounds: 77 cm apart		Hg-discharge tube Diam: 2 cm, Length: 34 cm Temperature of glass wall 18.5 °C (coldest point, cooled side tube) Sounds: 15 cm apart	
1 Current A	0,45	3,12	0,8	1,5
2 Gradient V/cm	1,51	0,96	0,617	0,57
3 W/cm positive column	0,68	2,99	0,493	0,855
4 Efficiency Lm/W	30,2	19,1	9,87	14,15
5 Temperature of glass wall °C	74,5	185	67	82,5
6 Losses through convection	39,7	33,7	43,1	37
7 Radiation from glass wall	44,8	48,4	50,5	56,6
8 Radiation from discharge	20,8	13,2	3,8	5,4
Total 6+7+8	105,3	95,3	97,4	99

Table III. Energy dissipation in the positive column.

Table III. shows the distribution of energy in positive columns of neon and mercury low-pressure lamps. I have determined it by direct methods, measuring separately the energy dissipated in the gas discharge, and in the material of the walls at the temperatures in question.

For the radiation from the discharge both the relative intensities of the series lines and the candle power were determined. The total radiation, the excess of which in comparison to the radiation from the discharge gives the radiation from the glass wall was also measured. The losses through convection and conduction were determined from two measurements of the wattage required for heating the tube to the same temperature of the wall. In one case the tube was exposed to air without protection, in the other it was shielded by another tube of large diameter and the space between both tubes was well evacuated. Correction was applied for the heat

* "Techn. Wiss. Abh. Osram," III., p.10 (1934).

transfer from the outer tube. Check measurements with direct determination of the radiation gave the same result.

	Type of lamp		Luminous Flux Hlm	Efficiency Hlm/W	Brightness Hk/cm ²
	Light of the positive column	Ne Co, and N ₂ Hg with fluorescent substances	250 (pro m) 200 to 400 (p.m.) depending on size	3 to 6 1 to 3 25 to 40	0.25 0.20 0.5 to 2
Pure gas discharge (luminescence)	Low pressure	Ne Hg	10 to 15 70 to 19	1 to 15 1 to 19	1 to 2 1 to 2
	Normal operating voltages	Hg Na	3000 to 6000 40 to 50	35 to 50 14	180
Temperature radiation in combination with gas discharge	High pressure	Hg	10000 to 50000	35 to 50	180
	Negative glow	Ne	1.5	0.5	0.02 to 0.03
Share of temperature radiation	large	Tungsten arc Carbon arc	400 to 10000 5000 to 18000	to 30 7 to 30	2000 to 3000 18000
	small	Beck arc Sunlight lamp	max 600000 —	10 to 30 U. V.	126000 —
Pure temperature radiation of solid bodies	Gas light with 4200 cal	Carbon filament	24 to 864 50 to 500	1.26 3.3	6 71
	Incandescent lamps	Metallic filament (formerly Os used lamps W)	160 to 220 160 to 1000 125 to 1250	6.7 6.3 10.9	— 82 240
		Tungsten (evacuated filament)	70 to 720 400 to 1000000	7 to 12 6.7 to 32	765 to 318 565 to 3600

Table IV. Data on the principal types of light sources.

In Table IV. some data are given on practical light sources, including the accessories.*

I may call your attention especially to the last column, for you will recall that just recently the physicist, C. Bol, has succeeded in making small mercury high-pressure lamps of 100 atmospheres, with intrinsic brilliances up to 40,000 candles per square cm., which is double the value of the brilliancy of the positive carbon of an ordinary carbon arc lamp. The values of the Bol-Lamp are not incorporated in the table.

Practical Applications of Electric Discharge Lamps.

Coming now to the third part of my address, which deals with some practical applications of the most important types of electric discharge lamps on the Continent, I would mention two applications, specially interesting for scientific purposes.

The first is the filtering out of spectral lines by colour screens. We have used for this purpose small vapour and gas discharge lamps with the following fillings:—sodium, helium, cadmium, zinc, thallium, magnesium, and mercury, and have obtained thirteen single lines in the visible spectrum.

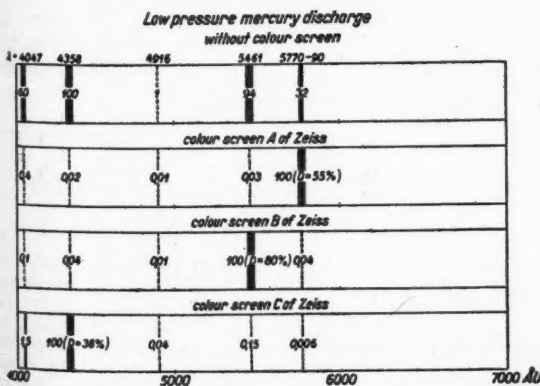


Fig. 5. Intensities of the mercury lines with and without colour screens.

In Fig. 5 we see the isolation of four visible lines of the mercury low-pressure discharge with Zeiss filters. You will observe that we have as a maxi-

mum no more than 0.15 per cent. of undesired lines, when the eye is used as a measuring instrument.

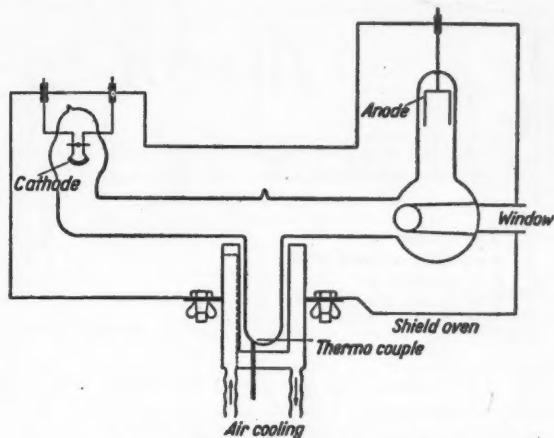


Fig. 6. Sodium primary standard of light.

In Fig. 6 a primary standard of light is shown which may, perhaps, later on replace the Hefner or similar lamp or the black body. It consists in a sodium vapour discharge tube of special shape, which is operated with 0.2 Amp./cm.² at a vapour pressure of 10⁻² mm. (temperature 300° ± 0.5C.).* The removal of the infra-red radiation of the sodium was performed by a copper sulphate filter. The lamp, as described by Schmellenmeyer, could be reproduced with an accuracy of ± 2 per cent.

Finally, I would like to give some data on the practical application of sodium and mercury lamps in Germany.

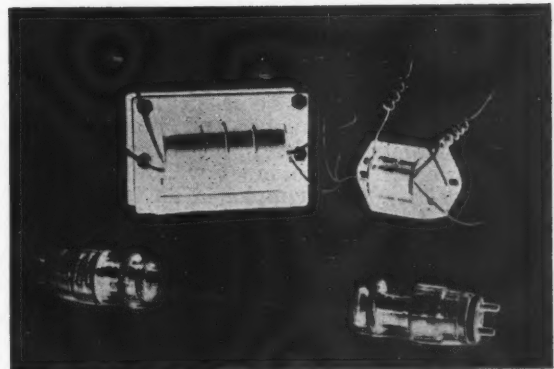


Fig. 7. Equipment for Sodium Vapour Street Lighting lamp.

In Fig. 7 you see a practical sodium lamp† introduced by the company with which I am associated in Berlin. It is for 220-volt alternating current, and is built for 3,000 Hlm, 1.15 amp., 70 watts, 55 volts on the lamp, and 50 Hlm/W, including the losses in the choke coil.

A second type used in Germany is built for 6,000 Lm. The construction is probably well known to you, and I need not explain it in detail. The lamp has two hot electrodes, like all gas-discharge lamps,

* "Zeitschr. für Physik," 93, p. 711 (1935).

† "Tech. Wiss. Abh. Osram," III, p. 15 (1934).

* "Die Physik in regelm. Berichten," 2, pp. 127—140 (1934).

for normal voltages. The tube strikes by means of an ignition resistance through two spark gaps.

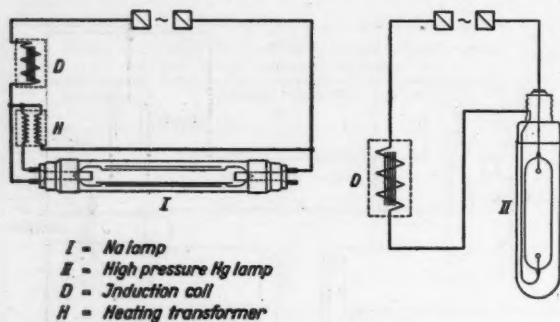


Fig. 8. Wiring diagrams of Osram Sodium and Mercury Lamps.

Fig. 8 (I.) shows the wiring of the lamp. Only one of the electrodes is heated. As the primary of the transformer is connected in parallel with the lamp, the input of the transformer falls to a small fraction of the starting value after the lamp has struck. The heating is in full operation only at the moment of striking. Afterwards the electrode is self-heating.

Fig. 8 (II.) shows the still simpler wiring of the Hg high pressure lamp, which is seen to be the same as the type used in this country. These lamps are built for 275, 550, 1,100 watts and give $35-50 \frac{\text{H.Lm}}{\text{W}}$.

In connection with these light sources I may say a few words on three practical questions which are:—

- (1) Compensation of the phase displacement on account of the choke coils;
- (2) The colour of light;
- (3) The high frequency disturbances.

The question of phase displacement on the Continent, and especially in Germany, is not so important as it may be here, because the field of application of the gas discharge lamps is more in the direction of private flood-lighting and sign-display. These again are more or less spread out over the different parts of the city. Therefore, owing to the relatively small number of lamps installed the disturbances are not appreciable.* The factories, which are relatively good consumers of discharge lamps, because of their good efficiency, mostly have their own central stations, and here again the phase displacement caused by the choke coils is of no great importance. We do, in a few cases, compensate with condensers, for example, in an installation of seventy-five 70 watt sodium lamps on a distance of 1,500 metres (10m. high), one condenser was used. The use of condensers instead of choke coils in series with the lamps has not, up to the present, led to success, because the capacity causes an over-voltage, which sometimes destroys the electrodes.

As for the colour question, we find no objection to sodium lamps in country street lighting, particularly when we provide rhodamine fluorescent paints on the street signs. The greater ease of vision in sodium light particularly with fine detail and with small illuminations (of the order of magnitude of 0.1 foot candles=1 Lux) gave occasion for its application in factories and outdoor installations like locomotive workshops. Fig. 9 shows a locomotive workshop lit with Na vapour lamps.

For the use of mercury lamps for indoor lighting, we tried to improve the colour by adding normal incandescent lamps, and although we are not 100 per cent. satisfied with this scheme, we often use a mixture of, for example, 250 watt 36 Lm/W Hg and 250 watt 16 Lm/W incandescent lamps leading to $26 \frac{\text{Lm}}{\text{Watt}}$ for the combination.

When colour discrimination is needed one must, however, use equal lumens for both and get much



Fig. 9. Sodium lamps used for lighting locomotive workshop.

poorer efficiencies. Such combinations, however, are not worse in efficiency and are more constant in colour than sources in which colour-correction by the addition of cadmium to the light of luminescent mercury is attempted.

As regards the high frequency disturbances caused by gas discharge lamps, we have not found any in the case of mercury. There were some with neon and sodium in individual cases. These, however, have been easily overcome by the addition of a capacity of $0.1 \mu F$ in parallel with each lamp and by dividing the choke coil into two and connecting one to each electrode of the lamp.

Choke coils in Germany are mostly supplied with means for regulating, whilst here they are provided with fixed taps.

As a rather modern application of the sodium lamp, I may mention the illumination of certain factories in places where small pieces such as screws and small discs are to be tested. With the mercury 1,000 watt lamp a special outfit was elaborated with ultra-violet transmitting glass for the making of positive copies. The lamp is used in horizontal position.

Conclusion.

Only a few years ago it seemed to everybody that illuminating engineering had reached a degree of perfection which could hardly be surpassed. To-day we see, that as well in the development of light sources as in the question of adaptation of illumination to different visual tasks, we are in the middle of a tumultuous evolution.

To bring this evolution to a happy end there must be a close collaboration between physicists, physiologists, illuminating engineers, psychologists, and last, but not least, economists.

This, I hope, will be the trend in the next few years, and I feel confident that the Illuminating Engineering Societies of the world will take a pioneer place in bringing this about.

Tungsten Filament Lamps

Revised British Standard Specification

British Standard Specification No. 555—1935* was formerly part of No. 161—1932 but now, in its revised form, is concerned exclusively with lamps other than those coming in the category of "General Service," i.e., vacuum H.V. 40-watt lamps, vacuum traction lamps, gas-filled traction lamps, vacuum train lighting lamps, gas-filled train lighting lamps, bus lamps, navigation lamps, double-capped tubular lamps, and lamps for road traffic control (electric) light signals. The specification is thus a comprehensive one, occupying 72 pages. For each form of lamp, dimensions, details of initial rating, and life performance are given.

An addendum to B.S.S. 161—1934, comprising a schedule for coiled coil filament lamps, has also been issued.

* Obtainable from the British Standards Institution, 28, Victoria-street, London, S.W.1; price 2s. 3d., post free.

* "Das Licht," pp. 1-5, 23-26, 86-89, 105-108 (1934).

Street Lighting and its Relation to the Safety of Roads

(Proceedings at the Joint Session of the Illuminating Engineering Society and the Association of Public Lighting Engineers, held in connection with the National Safety Congress in London on Friday, May 31st, when a paper on the above subject was read by Mr. S. B. Langlands, J.P., Inspector of Lighting to the Corporation of Glasgow; Sir John Pybus, Bart., C.B.E., M.P., in the Chair.)

There was an excellent attendance at the joint session of the Illuminating Engineering Society and the Association of Public Lighting Engineers, held in connection with the National Safety Congress at the Park Lane Hotel, London, on May 31. The National "Safety First" Association deserve congratulation on their enterprise in arranging this successful meeting, and on the choice of the lecturer, Mr. Langlands, of Glasgow, who is a Vice-President of the Illuminating Engineering Society and a Past-President of the Association of Public Lighting Engineers, and stands high in the esteem of both bodies.

THE CHAIRMAN (Sir John Pybus, Bart., C.B.E., M.P.) in opening the session expressed satisfaction at the large attendance, and emphasised the importance of good lighting in every field of activity. During the past few years the knowledge of the effective use of illumination had been developed in an extraordinary manner, and already an excellent return for the research in this field was being earned. This paper was concerned with one special problem—the lighting of the highways of our great cities. Those who had studied the subject could not resist the conclusion that there was much yet to be done to improve the lighting of highways throughout the country.

Recent Developments in Street Lighting.

Mr. Langlands, in opening his address, expressed the gratitude of the Illuminating Engineering Society

and the Association of Public Lighting Engineers to the National "Safety First" Association for affording them an opportunity of placing the claims of Street Lighting as an essential public service before its members.

At the outset, he wished to commend, as a safety measure, the step taken by the Ministry of Transport in appointing a Committee "To examine and report what steps could be taken for securing more efficient and uniform street lighting, with particular reference to the convenience and safety of traffic." One of the most important recent developments was undoubtedly the creation of this Ministry Committee. It was their desire, as concerned with the safety of the general public, to aid in every possible way the Committee's deliberations so that its ultimate decisions might emphasise the need for effective street and road lighting throughout the country.

Legislation Compelling Effective Public Lighting.

Mr. Langlands next emphasised the need for legislation compelling effective lighting of built-up areas. The present Acts of Parliament under which the major portion of the country carries out lighting say that local authorities "may" light. This, he contended, should be changed to "shall" light. The Act of Parliament governing the lighting of the City of Glasgow had a very effective Clause in the Glasgow Police Act, 1866, and this has been continued in



Anniesland Cross, Glasgow; a striking night photograph showing the combined effect of public lamps and illuminated guard posts.

subsequent Acts, with some slight amendment of the phrasing to bring it up to date. The Clause reads thus:—

"The Board shall make provision for lighting in a suitable manner the portions of the turnpike roads within the City, and the public and private streets and courts, and may, with that object, erect or continue and maintain upon the causeway or upon the foot pavements, or may affix to the walls of any buildings adjoining the said roads, streets or courts, or to the railings in front of such buildings, or to the walls of any land or heritage adjoining the said roads or streets, the necessary lamps, lamp posts, lamp irons and other appurtenances, and may from time to time alter the position of the said works..." Further, the whole lighting of the City is paid out of the general assessments with this proviso that the amount assessed in any one year shall not exceed 9d. in the £ of total rates.

The same Act made provision for an Inspector of Lighting, and the powers accorded to this official proved of the utmost value for the advancement of public lighting in the City. The relevant Clause reads:—"The Inspector of Lighting shall be responsible to the Board for the proper erection, maintenance, and renewal of the said lamps, for the proper maintenance and renewal of any lamps now in use, for keeping in order all such lamps, for lighting them during such hours as the Board may from time to time direct, for the good conduct of the lamplighters and other persons appointed by him, and generally for the complete state of efficiency of his department."

The authorities should appoint a public lighting engineer for places with, say, over 50,000 inhabitants, this public lighting engineer to be responsible for the lay-out and maintenance of effective lighting schemes. "Maintenance" is perhaps the most important factor in public lighting. In many cases good schemes have been drawn up and carefully planned, but afterwards maintained in so slipshod a fashion as to nullify the first efforts. This call for good lighting and good supervision may mean the shifting of the responsibility for the lighting of smaller towns or villages from, say, Urban District Councils, on to the broader shoulders of the County Councils, to ease assessment, and make possible the appointment of an efficient lighting engineer with a large enough area. Thus could be grouped together places either adjacent or separated but all needing light—and proper light. At present most of these places have independent lighting authorities: so independent that few can get proper lighting for themselves.

Towns and Cities First.

In discussing the basis of a national scheme of lighting Mr. Langlands advised that attention should be concentrated on the bigger places; cities and towns first, good-sized villages next and then main roads. The British Standard Specification for Street Lighting furnished an excellent basis for operations. Let a start be made without waiting for possible future improvements in its constitution. Then good examples would inevitably lead to improvement elsewhere. If only lighting such as that specified under Clauses D, E, and F of the Specification could be secured, this alone would be a tremendous step forward. Such lighting as this would mean greater safety to—and from—traffic, and also greater safety from another aspect—policing—in which connection all night lighting proved its value. It would mean better cleansing and would certainly be an aid towards road and street maintenance.

No doubt the deliberations of the Ministry Committee will mean the appointment of a Government officer whose duties will be to see that the authorities

throughout the country sufficiently light their streets and roads, and many of the powers at present possessed by local authorities may require to be transferred to the Ministry just as has occurred with the control of the roads of the country. Cities and towns ought to be so completely lit that it should be an offence to use a motor-headlight therein. The Government might try out, in certain of the larger towns, complete experiments with every kind of lighting apparatus, a street here and there being improved, rather than any one length of road taken for experimental purposes only. The experiments should be of use to some city or town and let the Government, if it cares, help out the local authority with the cost of the experiment. One of the most difficult things in the world is to visualise groups of lights superimposed upon each other. It is much easier to contrast installations which are distinct and apart.

Standard Rates for Gas and Electricity.

Mr. Langlands urged what might be considered by some an Utopian idea—standardisation of the prices for gas and electricity according to the quantity taken. The great cities might get their gas for anything from 9d. to 1s. per 1,000 cubic feet, and electricity from ½d. upwards per unit; but there ought to be a maximum price of 2s. for the former commodity and 2d. for the latter. The Supply Authorities or Companies should remember that the gas or electricity taken for public lighting is a real source of revenue to them because services, pipes and cables, are for the most part of short length and no meters are required; the price of supervision disappears, and many of the things which are given to consumers to induce them to use the product and the cost of which is added to the cost of production are also saved. A cheque is given four times a year, so that there are no bad debts. Altogether public lighting is one of the best consumers that gas or electricity could have, more especially as the consumption runs from dusk to dawn and, if a little of it may be on the peak load, the most is off it. If this stabilisation of price could be obtained it would be easier for public authorities to assess what public lighting should cost each year and control each other's work by real comparisons.

Some Recent Technical Developments.

Mr. Langlands next turned to certain technical matters, such as installations of electric discharge lamps. Here there was a great advance towards better visibility, but the colour of the light was a difficulty. Combinations of electric discharge lamps and incandescent (filament) lamps had been suggested, but the solution would be correction within the lamp, and he was sure that this would come.

In regard to fittings, he spoke of the "craze for directional fittings and focussing." A certain amount of directional lighting was good, but in everyday practice the need for careful adjustment towards focussing presented difficulties. A man sent out on a tower waggon to do his cleaning might easily send things awry, and the last state of that lighting might be worse than the first!

In connection with gas lamps he urged the adoption of larger high pressure units—low pressure units mounted at greater heights.

In fact he himself wanted to "go high, have big units, and perfectly diffused lighting, with as little directional gear as possible.

"The future holds tremendous possibilities. We, for instance, are mapping out our town for switch control of lighting, reducing the number of divisional offices throughout the city from thirteen to eight in the first instance, and possibly four as a final arrangement. This means that divisional offices change from muster rooms to switch control stations. At present we have almost finished one huge station

in the west of the city and have had big success in our efforts."

Effect of Road-Surface.

Mr. Langlands explained that his comments on directional lighting were not intended as a disparagement of the work of the group of theorists who had grown up around public lighting, which he greatly appreciated. He suggested, however, that theories of road-surface brightness, etc., should not be put forward until methods of assessing and measuring were available. Personally, he would rather have "the brightness of the surface than surface bright-

mitted to the Institution of Municipal and County Engineers from my department in June, 1932. Keen as was the argument between the supporters of diffused lighting—in its various degrees—and of directed lighting—in its various degrees—as giver of the better visibility, they agreed in having preferences among the materials for the street-surfaces which the road engineer put down to reflect the lighting engineer's illumination. These preferences were not all the same. Difference of opinion was probably greatest on the desirability of polish. Personally, he wanted a good diffusing reflector, reflecting from all



(1) Glasgow Cross (Wet)

Surface of Carriageway—Nidged granite setts. Footways—Granolithic.



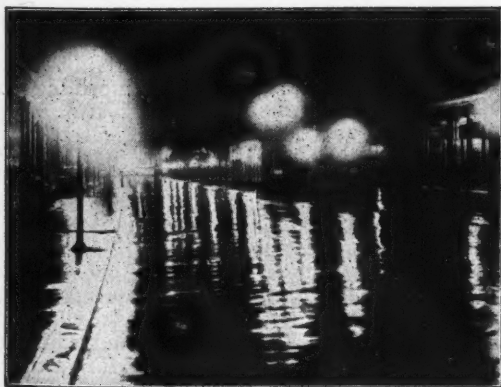
(2) Glasgow Cross (Dry)

Surface of Carriageway—Nidged granite setts. Footways—Granolithic.

ness." By this he meant that he was anxious to get co-operation between city engineers and the lighting engineers to obtain street surfaces of a brighter nature. He hoped, with the co-operation of his city engineer, to make further tests along this line by taking a street and applying different colours along its surface and finding out what is to be gained and what is to be lost. This might sound fantastic, but he did think there was knowledge to be gained in this way.

Mr. Langlands then threw on the screen four slides showing two Glasgow streets under wet and dry

points to observers at all points. He could appreciate the brightening effect upon the background of a little polish, when it was not destructive of general reflection. If one looked away down the streak of direct reflection that came over a polished surface from a distant source, one found that, in both actual and figurative senses, a little polish went a long way. All, however, who argue with each other about street-lighting, were in general agreement on the desirability of "light" surfaces. Moreover, others besides those who have to purvey public lighting are becoming more and more impressed with the importance



(3) Queen Street (Wet)

Surface of Carriageway—Compressed Rock Asphalt. Footways—Flags.



(4) Queen Street (Dry)

Surface of Carriageway—Compressed Rock Asphalt. Footways—Flags.

conditions, the streets having different paving. These four illustrations appear above. The first two are of Glasgow Cross, where the carriageway consists of nidged granite setts and the footways seen in the background are of granolithic. The first photograph shows the surface wet. The second photograph shows the surface dry. The next pair were taken in Queen-street where the surface of the carriageway is of compressed rock asphalt and the footways are flag-stones. Here again is illustrated the difference in appearance with wet and with dry surfaces.

This whole matter of street surfaces, Mr. Langlands remarked, was fully dealt with in a paper sub-

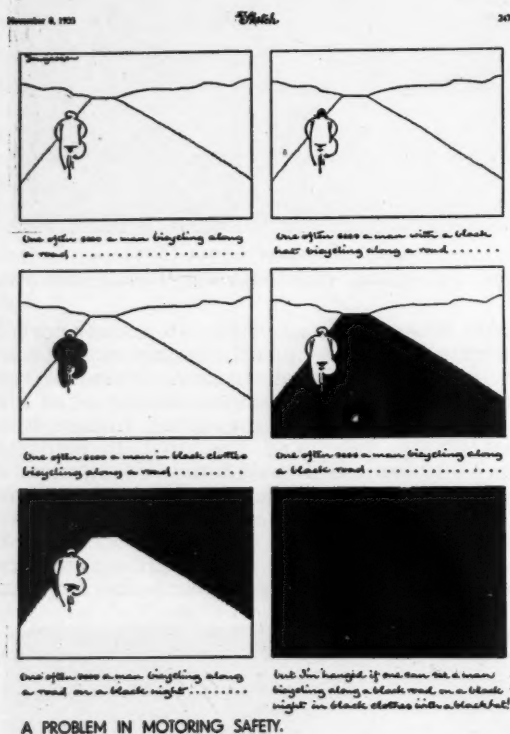
of the street-surface as a background for vision and with the value of "light" or properly reflecting surface-materials. These important "others" include road-engineers as such, motoring organisations, writers on motoring, motorists, and other lay users of the streets, and, particularly, as the men who make the views of all these effective, the Government officials.

During the final portion of his address, Mr. Landlands threw a picture on the screen which illustrated the co-operation which existed between the engineer and himself in Glasgow, where lighting and street

control were achieved by co-operative working. This was a view of Anniesland Cross (see p. 259), one of the biggest street junctions in Glasgow, with six main thoroughfares branching off. The skilful design of the traffic control lay-out, with its "Keep Left" signs and guard-posts, was the work of the city engineer, Mr. Thos. Somers, M.Inst.C.E. The street lamps, no more numerous than the situation demanded, were seen on the tall poles, mostly tramway standards—another example of useful co-operation and sanction among municipal departments.

Conclusion.

In conclusion, Mr. Langlands said that he looked forward hopefully to the solution of many of the problems which have arisen regarding well and completely lit roads and streets, and he could not do better than show a slide by an eminent "Punch" artist, which seems to tell the whole tale.



By permission of the artist and the Editor of "The Sketch."

The respective sections of the slide read:—

- One often sees a man bicycling along a road.
- One often sees a man with a black hat bicycling along a road.
- One often sees a man in black clothes bicycling along a road.
- One often sees a man bicycling along a black road.
- One often sees a man bicycling along a road on a black night.
- But I'm hanged if one can see a man bicycling along a black road on a black night in black clothes with a black hat.

[We are indebted to the National Safety First Association for the illustrations accompanying the above paper.—Ed.]

DISCUSSION.

Mr. C. C. PATERSON (General Electric Co. Research Laboratories) commented on the intentionally provocative manner in which the paper had been prepared. As regards some portions of it, he was provoked to bless, as regards others, he was perhaps provoked to suspicion and condemnation, but all the time the paper was undoubtedly stimulating. As a member of the Ministry of Transport Committee, he thanked the author for the kind and sympathetic references in the paper to the work of that committee. That work—in which the author had helped a good deal—was by no means easy, and, having regard to his own position as a member of that committee, he was precluded from touching upon some of the points raised in the earlier part of the paper. It was possible, however, to make the general observation that in trying to lay down any conditions for street lighting we must not stultify progress nor be mesmerised by existing barely adequate standards of lighting. Whilst endeavouring to do all that was necessary for present conditions, standards of lighting which were adequate at one time—as had been found in other branches of illumination—might be found quite inadequate ten years later. There were many ways of carrying out effective lighting, but one of the dominating factors in judging between various schemes was economy. Safety on the roads required good visibility, but we must have visibility with economy, and it was in this connection that he found himself critical of some of the points in the paper. For instance, the colour of the light from electric discharge lamps had been criticised, but if it were possible to get light which whilst perhaps not of the most perfect colour, was nevertheless two or three times more efficient than the light being obtained at the present time, was it not worth while using that light for the sake of securing visibility economically?

The paper also referred to what was called the focussing craze, and he agreed with the author that there was a time in street lighting development when directional fittings were so directional that focussing was actually an art, and the conditions were such that the light distribution could easily be upset during the life of the installation. That phase, however, was tending to pass, and it was being realised that fittings must not be supplied in which the focussing was very critical. There must be a large margin of safety so that the person who maintained the installation had no difficulty in doing so, and in maintaining it in a really good state of efficiency. Therefore, he would ask the author the question, Why use 500-watt lamps—if he might talk in terms of electricity for the moment—with a spacing of 120 feet and obtain moderate visibility with non-directional fittings and a colour which happened to suit everybody's taste, when it was possible to get a really high visibility with lower wattage fittings at greater distance, using directional fittings and a colour of light which was perhaps not perfect in every respect? He knew from personal experience that Glasgow was a well-lighted city, but it was very liberally supplied with power in its street lamps. He was looking forward to the day when, with the same amount of power, Glasgow would be magnificently lighted!

There was one paragraph in the paper, continued Mr. Paterson, which he knew the author would not expect him to leave without comment, that in which he disclaimed disparagement of the work of "the group of theorists who have grown up around public lighting," but asked them not to put forward theories of surface brightness, and so forth, until they had the means of assessing and measuring. Perhaps he might suggest to the author that the theorists explained existing results; the people who were referred to as the theorists were seeking to explain—and were succeeding in explaining—phenomena which were being used and had been used for some time. To those who clung tenaciously to their self-inflicted empiricisms, street lighting was a

mysterious and difficult art, but his own view was that we ought not to be so hypnotised by its complications. Street lighting was no more difficult than any other art when it was explained by laying down properly proved principles and properly proved theories, and he was proud to reckon himself as one of the theorists, and, as a matter of fact, he was inclined to think that the author was also a theorist, in spite of his little gibe! In regard to the reference in the final part of the paragraph mentioned, he thought that the very first thing the theorists had done was to show that there were means for assessing and measuring, and they did, in fact, assess and measure.

Continuing, Mr. Paterson said he had always been with the author in his desire for road surfaces which are light in colour. It would be very nice to have all roads relatively light in colour, but it must be admitted that we were tied for the present to road surfaces which were made up with tar products which were black, and there was no real expectation in the near future—or even in the rather far distant future, as far as could be seen—of getting away from these tar products. We had dark surface roads which tended to get a slight gloss upon them, and these were the roads which we must accept in all our work upon street lighting in the endeavour to produce the best visibility.

Finally, Mr. Paterson referred to the advice given in the paper to the gas industry to think in large units and high posts, and asked why that was directed only to the gas industry. Could not the electrical industry also have the benefit of that advice, because they all needed to learn this lesson.

Councillor A. J. BALDWIN (Heston and Isleworth U.D.C.) asked for further information with regard to electric discharge lamps, centrally suspended lamps, the type of reflector to be used according to the wattage of the lamps and the height of lamp standards.

Mr. J. M. WALDRAM (General Electric Co. Research Laboratories) said he had recently been in Glasgow and had taken the opportunity of looking at the street surfaces and the effect of the street lighting policy adopted there. Undoubtedly the author had made a very fine job of the Glasgow street lighting; and to see for mile after mile 500-watt or 300-watt lamps at 120 ft. spacing on 25 ft. posts would make many engineers envious. There were not many places where such installations were to be found. He was tempted to reply to the author's comments on theorists. It might be said that theory and practice were like a man and his wife: they were only subjects for comment when they were separated. Recently, however, street lighting theory was escaping that criticism because it was taking more and more notice of the actual practical conditions of visibility, and it would be interesting if the author, in the course of his reply, could say something more in detail of his experience in the matter of visibility.

Mr. WalDRAM then showed a number of slides. The first four indicated the conditions of lighting of a road under which a motorist cannot see objects on the road a short distance ahead, and conditions of lighting in which this difficulty is for all practical purposes overcome, without the use of headlights.

The mechanism of visibility had been the subject of considerable investigation, especially from the point of view of obtaining a high brightness of the road surface in order to obtain a background against which objects in the road were silhouetted. Recently he had been in Glasgow and had been able to take some photographs and measurements of brightness which, he felt, absolved illuminating engineers from the charge made in the paper that they were not able to measure. The general level of street surface bright-

ness in Glasgow was 0.1 to 0.2 equivalent ft.-candles. The best lighted street he had found in Glasgow was Argyle-street, where the brightness varied from about 0.5 down to 0.2. In this street the consumption was about 1,250 watts per 100 ft.

In Queen-street the brightness was a little less—about 0.3 equivalent ft.-candles—and the consumption amounted to 830 watts per 100 ft. In that case the surface of the road was asphalt. There was an exactly similar installation in Union-street where the surface was cobbled setts, and the brightness in that case was only 0.15, the consumption being 800 watts per 100 ft.

In comparison with these results, Mr. WalDRAM showed some slides illustrating what could be done by the use of directional lighting. The first slide was of an installation—not in Glasgow—in which the total consumption was 330 watts per 100 ft., or one-quarter that in Argyle-street, Glasgow, but the brightness was about the same; whilst if the focussing of the installation was changed it was possible to increase the brightness to 0.7 equivalent ft.-candles as compared with a maximum of 0.5 in Argyle-street. In another installation of 300-watt tungsten lamps on span wires 120 ft. apart, using enamelled reflectors, the brightness was under 0.1 equivalent ft.-candles, the consumption being 500 watts per 100 ft. This was compared with an installation using electric discharge lamps, the brightness in which was 1.0 equivalent ft.-candles, or 10 times that shown in the previous installation, with almost exactly half the watts consumption.

This, continued Mr. WalDRAM, demonstrated what it is possible to do by careful control. He emphasised that in the last installation, to which he had referred, although directional gear was used, there was no focussing adjustment.

As an example of the effect of distribution of light on the brightness of the surface Mr. WalDRAM showed a slide of Bath-street, Glasgow, in which a lantern having an opal skirt could be seen between two fittings with clear globes. The greater extent of the bright patches on the road from the latter lanterns was apparent.

The surface of "nided setts" to which Mr. Langlands had referred, seemed excellent for street lighting, for it generally took on the slight polish which led to good brightness distribution. There was, however, considerable variation between samples; nided sett surfaces seemed to have properties varying from very matt to those of shiny asphalt. Mr. WalDRAM agreed that highly polished surfaces were undesirable.

Mr. J. H. GORDON (Lighting Inspector and Chief Constable, Paisley) referring to the colour of electric discharge lamps, said that although as lighting inspector he agreed they gave excellent visibility, as Chief Constable he appreciated the risk of a drunken man lying in a road so lighted being mistaken for a dead man with possibly awkward consequences! Again, as Chief Constable, he felt that difficulties might well arise in the identification of a person committing a crime and seen at the time under the colour of this form of lighting. It would be difficult to identify him later, perhaps, in daylight or in the usual form of artificial light.

Mr. TOM REGAN (Manchester) asked for further information of the control apparatus designed to switch on according to the degree of natural visibility. The time-switch, he added, did not fit in with nature in that way, and with it there was every possibility of there being a dark night and no street lamps on because the darkness had come on sooner than it did normally. He believed that greater progress would have been made with such apparatus if it had been less expensive. Nevertheless, in the interests of saving life he believed that expense incurred in such direc-

tions was justified, and so far as his own city was concerned he did not care whether it cost £50,000 or £100,000 to provide such safety devices if it meant saving only one or two lives. He asked the author whether he had any statistics as to the incidence of accidents at dusk which might be in favour of the adoption of such methods. Speaking of electric discharge lamps and the only disadvantage, in his view, of them, viz., colour, he suggested that it was better to look deathly but alive than not to look deathly and run a bigger risk of being killed. Therefore, he urged that the electric discharge lamp should be adopted more widely in the interests of safety rather than that it should be rejected merely because of its colour.

M. VIGNON (Touring Club of France) referred to the experiments which have been carried out on the road between Paris and Versailles. Over a distance of one mile the ordinary incandescent lamps were used, whilst on another stretch of roadway some two and a half miles long, sodium lamps were used. It appeared that the equivalent result was obtained in the latter case with a considerably less expenditure of electricity. The light from these lamps was yellow, and very much the colour of the glass used in motor-car headlights for fog penetration. Apart from the disadvantage of colour, the sodium lighting had the advantage that it was not necessary for motorists to have their headlights on so that they could see the on-coming traffic without difficulty. M. Vignon added that the manufacturers of lamps in France were paying the cost of this experimental lighting for ten years. He suggested that it might be possible to get manufacturers in this country to make some similar arrangement.

Mr. F. J. BLACKMORE (Bombay) referring to some tests of electric discharge lamps at Blackheath which he had just witnessed, pointed out that the road on which these tests had been carried out passed on to open common, which was not well lighted. When he had reached this open common he noticed that there had been an accident, and without knowing the details, he thought that this had quite possibly occurred through the sudden change of illumination, and the difficulty of adjusting oneself quickly when going from a well-lighted area to a badly or less well-lighted one. Therefore, he suggested to street lighting engineers that these changes of illumination should be eased off and not be too abrupt. Mr. Blackmore added that he is a member of the Safety Association of India as well as of the Association of Public Lighting Engineers.

Mr. F. C. SMITH (Gas Light and Coke Co.) suggested that the truth of what the author had said as to theorists would be found to lie between the position taken by the author and the position occupied by those who had been giving expression to views which the author would probably characterise as theories. The author, who looked on the practical aspect of public lighting, had admitted that he was fortunate in Glasgow in that there was a fair wattage per unit of length as far as electricity was concerned and also a fair consumption of gas per unit of length. Some of the speakers had urged economy by the use of directional equipment and an increase in the spacing of the lamps. In spite of what the author had said most lighting engineers believed that directional equipment properly applied had its rightful place. There was no question about it that if one could direct the light in a reasonable way good effects could be produced together with economy. On the other hand no amount of ingenuity, no amount of craft and no amount of skill in the use of directional equipment could replace the need for supplying an

adequate flux of light. There was no doubt that in this matter the theorist had his place and that road surface brightness was a matter of importance. Where personally he failed to go all the way with Mr. Waldram was that notwithstanding the enormous amount of experiment and hard thinking that had taken place on the part of Mr. Waldram and his colleagues who were working along similar lines, they sometimes failed to realise that other backgrounds were of just as much importance as the road itself.

Continuing, Mr. Smith said that he observed that there had been a complete absence of any reference to glare in the paper and discussion. There were some who believed that the high intensities near the horizontal which went to promote high road brightness might, on occasion, result in dangerous glare. If there was a good flux of light with reasonable distribution so that glare was avoided, we should have gone a long way to bring about the condition of affairs that was necessary, viz., contrast of brightness between the object to be seen and the background of the object. Whether that result could be brought about entirely by high road brightness remained to be seen, and although it was not the whole story it would, undoubtedly, go a long way.

In conclusion Mr. Smith reminded those present that this Conference had not been called to consider the merits of gas or electric lighting, but rather to determine the fundamental requirements of a well-lighted road; having ascertained those requirements it should be left to the commercial man to determine which illuminant could do this work at the least cost.

Captain W. J. LIBERTY remarked that as a member of the Public Safety Committee of the Safety First Association he was interested in the request that had been made by one speaker as to the incidence of accidents at dusk. This was linked up with the incidence of accidents in poorly-lighted streets as compared with well lighted streets, and it was a matter which had been causing some concern to the National Safety First Association. Two years ago a very careful analysis was made of the accidents that occurred during the hours of darkness. Some caution should be exercised in attempting to draw conclusions from the results, which at first sight were perplexing. He observed for example, that there were actually more accidents recorded on roads with relatively good lighting than on roads where there was poor lighting or none at all. It would be helpful if the author could give some enlightenment on the matter because one would not wish the inference to be drawn that by reducing the efficiency of street lighting the number of accidents could be reduced!

Mr. W. J. JONES, remarked that the author with his peculiar Scottish ability had put his finger on two very important factors which determine satisfactory lighting for streets, viz., the administrative and financial aspect, and what was equally important, the fundamental factors affecting visibility. It was suggested in the paper that towns with a population of 50,000 and over should have a fully qualified lighting engineer, and those who had watched this movement towards better public lighting would concur in that suggestion. Nevertheless, he himself would make the plea that that was insufficient by itself and that there must, in addition, be some co-ordination between contiguous towns to ensure a satisfactory scheme of main road lighting from one area to another. It was only necessary to consider the ridiculous state of affairs that existed in certain parts of London to appreciate this. For instance, on the North Circular Road there were within a distance of thirteen miles, twenty-seven different lighting changes, giving an illumination from practically nothing at all to the best that was obtainable. That

condition could readily be remedied by reasonable co-operation between the various public lighting authorities.

On the fundamental questions of seeing and visibility, referred to in the paper, he suggested to the author that it was not only a matter of road brightness or brightness of background, but a question of relative brightness of the object being looked at, as well as the background. Whilst we had no control whatsoever over the colours of the suits which people wore or the blackness of their overcoats, it was possible to control, within certain limits, the brightness of the background. It was for this reason that many of the theorists placed so much reliance on the modern view of ensuring that the background had a sufficiently high brightness value. He hoped that as a result of this Conference, these two important aspects of the problem would be discussed further with a view to making a definite effort to reduce the number of road accidents. If Captain Liberty would examine the statistics he had referred to more thoroughly in relation to the incidence of traffic as well as the number of accidents which actually occurred at these points, he would find that there was a very much closer relationship between good lighting and the scarcity of accidents and between bad lighting and a large number of accidents than might at first sight appear.

Mr. CECIL STRAPP (Surveyor, Wembley U.D.C.) remarked that the better lighting of the main roads was a question of economics, and pointed out that many of the roads in a district were not local, but provided for through traffic. Therefore they could not be regarded as a local concern. In his own case, the Council had decided to light practically all the main roads in its area with electric discharge lamps, but he contended that as grants were made by the Ministry of Transport in respect of roads, so grants should be made from the Road Fund for the lighting of the main roads of the country.

Mr. WILLOUGHBY GARNER (Ealing), referring to what Captain Liberty had said, remarked that his experience as a motorist was that the safest road was one in which there was no lighting at all and the motorist relied upon his headlights. There was, however, a very good installation of street lighting in Kennington Park-road. Elsewhere the roads were less satisfactory. There was a great need in London for a uniform system throughout. The area was something like twenty-five miles across, and at present there were all manner of variations in the efficiency of the illumination in the various districts.

Mr. SEPTIMUS BARK (Liverpool) called attention to the excellent system of lighting in the Mersey Tunnel through which an enormous amount of traffic had passed, and there had been no complaints.

Mr. PERCY GOOD (British Standards Institution) supported what the author had said as to not waiting for perfection before putting a street lighting specification into operation. He had watched the work being done by the Committee presided over by Mr. Paterson, and knew that many people still felt that the specification was far from perfect, but the policy should be to make the most use of what was available until it was possible to secure something better. As regards what had been said concerning theorists, he reminded the author of the remark by Disraeli that the practical man is the man who practises the errors of his forefathers. That should be taken to heart in an endeavour to bring about co-operation between the theorists and those who practised in all this work.

Councillor FRY, R.N. (Deputy Mayor, Cheltenham), emphasising that good illumination was not

the amount of illumination on the individual but the contrast between the individual and the background, suggested that far more attention would have to be given to street illumination from this point of view if really good visibility was to be ensured.

Mr. A. DUNSCOMBE ALLEN (Deutsche Auto Club) remarked that street lighting developments in this country are being watched with great interest abroad. Continuing, he criticised the position that had arisen owing to the fact that many highly efficient lighting systems were being installed, whilst, simultaneously, the Minister of Transport had ordered that all motor-car horns were to be silenced between 11.30 p.m. and 7 a.m. In these circumstances, he asked what the motorist was to do at a cross-road where the degree of illumination was such that signalling with his headlights was not much use? Was he to slow down and come to a stop and then create noise in changing gear and "revving" up his engine, or was he to chance breaking the law and use his horn? The alternative seemed to be a lesser degree of lighting at cross-roads which would permit of a signal being given by the use of the headlights of the approaching motor-car.

Mr. S. B. LANGLANDS, replying to the discussion, said that despite the intensity of the criticisms of the paper—which was exactly what he desired — they all had the same object, viz., good lighting and safety on the roads. He emphasised, however, that we should not wait for perfection before going ahead. Mr. Paterson was very keen on getting things exactly right before he would try them, but if that policy had been adopted in Glasgow, they would have been waiting still and Glasgow would be a black hole. In Glasgow they had taken a chance, and nowhere had there been more experiments carried out or more lamps tried. In no other place had there been equipped a laboratory such as was to be found in Glasgow and, although the work carried out in that laboratory had been, he hoped, scientific, it had at all times been practical. Reference had been made to economy, but could not economy be carried too far? In this connection, Mr. Langlands referred to adverse expressions of opinion in regard to the colour of the electric discharge lamp in Glasgow, where, however, they hoped to carry out further experiments. They had some thought for the aesthetic side in Glasgow, and, at the same time, they had some regard for the motorist, who had been specially pleased with the efforts that had been made to give them a soft, gentle, diffused light instead of something glaring.

The questions asked by Mr. Baldwin he would be pleased to answer in detail in writing on hearing further from him. He had been pleased to hear that Mr. Waldram had visited Glasgow, and wished he had had the opportunity of seeing him, because Mr. Waldram knew how anxious they were in Glasgow to co-operate. Mr. Waldram was one of the pioneers on this question of surface brightness, and all credit was due to him. The point was that Mr. Waldram looked at the matter from one angle, and he was looking at it from another because he had wanted the city engineer and surveyor to work in with him and give the surface and backgrounds that were wanted. That happy co-operation could only exist between people having the same purpose in view. It had been suggested that Glasgow was extravagant in its street lighting, but was it extravagance? If he kept within his maintenance allowance and gave people what they wanted and satisfied them, was he not justified. His view was that, first of all, the amount of light required should be obtained and then an effort could be made to pare down the cost if that were possible.

As regards the request by Mr. Regan for information concerning automatic control of public lighting

he would give full details, if desired, as far as he had them, in writing. He might mention, however, one difficulty—that the device in use would not work in fog, because the particles of aqueous vapour in the fog prevented it functioning.

Commenting on what M. Vignon had said with regard to sodium lamps, Mr. Langlands said he was carrying out some experiments at the moment, but could not hope that the lamp manufacturers in this country would be so altruistic, as apparently they were in France!

In reply to Mr. Smith, he said that gas was used for street lighting in Glasgow, together with electricity, in the ratio of 50:50. He had not raised the question of gas versus electricity in the paper. In the same way he had kept off the subject of glare, because it was such a large one. He agreed with Mr. Smith on the question of backgrounds.

The statistics mentioned by Captain Liberty served to bring home the point that if a street was well lighted, the motorist was inclined to put his foot down hard on to the accelerator because he had plenty of light. That might be the reason for what Captain Liberty had pointed out. At the same time, he did not think those results had any real bearing on the subject dealt with in the paper.

The problem of London, mentioned by Mr. Jones, was too much for him. Glasgow was bad enough, but obviously there should be some co-ordination between adjacent authorities. In Glasgow they were happy in that the city was one area, whereas London was a parcel of little peoples.

As to the use of headlamps, he would place any motorist in prison who used his headlights in a properly lighted thoroughfare, and in his view the streets of the large towns should be lighted so that head-lights were not necessary.

In Glasgow they were grateful to Mr. Good and his committee for the street lighting specification, which was being continually used there, and again he urged that we should not wait for perfection.

Questions relating to silhouetting and other technical points had been left out of the paper, having in mind that this Conference was a Safety-First Conference. For that reason the paper had been made as general as possible. If, however, the paper had the effect of causing people to become light-conscious then he would be happy. The noblest things, said Dean Swift, are "Sweetness and Light."

On the motion of the Chairman a cordial vote of thanks was passed to Mr. Langlands at the conclusion of the discussion.

The Conference closed with a vote of thanks to the Chairman, which was proposed by Mr. A. M. Bell (Vice-President, Association of Public Lighting Engineers).

Illumination and Visibility of Work as Factors in Scientific Management

A useful contribution on the above subject, by Major H. C. Gunton and Mr. H. C. Weston, was presented at the International Congress for Scientific Management held in London last month. We propose in our next issue to give a summary of this contribution and also of the report by Mr. Weston on the "Relation between Illumination and Industrial Efficiency (Effect of Size of Work)," issued jointly by the Industrial Health Research Board and the Illumination Research Committee (D.S.I.R.). A brief reference to this important piece of work was made in "Literature on Lighting" in our last issue (No. 215, page 237).

Public Lighting in Sheffield

The Report of the Public Lighting Engineer of Sheffield (Mr. J. F. Colquhoun) for the past year is, as usual, illustrated by a series of graphs which are very helpful in showing the progress of work year by year. One observes that whilst the net annual expenditure diminished almost continuously during the period 1927-1934 the "candlepower per head" has increased consistently ever since the formation of the department. Since 1934 there has been an upward rise in the curves of expenditure and cost of lighting—by no means a feature to be regretted, especially bearing in mind the evidence of severe economies in the "slump" period.

One observes that from August 1, 1934, the full responsibility for the maintenance of all public lamps lighted by electricity was placed on the Lighting Department. Of considerable interest is the record of work done by the Testing Department, which checks all electric lamps for consumption, light-output and efficiency. Of the 22,468 lamps tested only about 1 per cent. were returned to the makers as defective. Approximately half the lamps had an effective life between 750 and 1,250 hours; 13.3 per cent. had a life of under 500 hours, but 19.4 per cent. showed lives varying from 1,250 to 1,500 hours. An inquiry into results on six different grades of gasmantles led to the conclusion that those of artificial silk, whilst equal in lighting value, were much superior to others in durability.

One curious discovery was that from October to March the numbers of nights on which road-surfaces were respectively "wet" and "dry" were almost exactly equal.

Association of Public Lighting Engineers. 12th Annual Meeting and Conference. London, Sept. 9—12, 1935.

For this forthcoming Conference a most attractive programme has been arranged (see *Illum. Eng.*, July, 1935, p. 235).

We understand that a record attendance is already assured.

Have you Registered?

Studies of Natural Lighting

A comprehensive report summarising an investigation of daylight in buildings has been recently prepared for the Public Health Service (U.S.A.) by J. E. Ives, F. L. Knowles and L. R. Thompson (*Public Health Bulletin No. 218*). Diagrams are presented showing the effect of variations in shape and dimensions of windows, assuming a sky-brightness of 100 candles per square foot, and an instructive comparison of results with walls and ceilings of varying reflecting value was made. The dominant importance of increase in the height of the window is emphasised. (Doubling the height of a window approximately trebles the illumination at the middle or rear of the room, whilst doubling the width of the window does not even double the illumination.) The average contribution of reflected illumination may vary from 17 to 82 per cent. of the total, the average being 51 per cent. Figures for the brightness of different parts of the clear north sky at Washington and for various periods of the year are given. Data reveal material variations in the brightness thus recorded, even for different sections of the United States.

International Commission on Illumination

Ninth Plenary Meeting in Germany

July 1st—10th, 1935

We hope, in our next issue, to present a detailed report of the proceedings at the above meeting, at which much useful work was done. For the moment we shall content ourselves with a brief general reference to the gathering, which was, by general consent, a most successful and enjoyable one.

The Session formally opened in the Reichstag building in Berlin on July 2, with the President, Dr. A. Meyer, in the chair. Dr. Lippert, State Commissioner for the City of Berlin, on behalf of the German Government, welcomed the delegates, amongst whom some eighteen countries were represented. It was pleasant to observe the interest in the work of the commission displayed by several additional countries. Spain sent a strong delegation in support of an application from that country for membership in I.C.I. Similar applications from Rumania and Russia have been received.

Excellent arrangements had been made by the German National Committee for the meetings. On several occasions there was a note of distinctive artistry in the hospitality shown to visitors—to their evident pleasure and admiration. In Berlin the Reichstag was placed at the disposal of the commission, so that work was carried on in great comfort and with a dignity in keeping with serious effort. In the famous educational centre of Karlsruhe the new buildings of the Technical University were made available. The original spherical photometer de-

signed by Ulbricht, of Dresden, and placed in the entrance hall, was an object of great interest.

Two instances of the happy touch, mentioned above, in the entertainment of visitors, may be singled out for special mention. The evening spent at the Schloss Monbijou and the beautiful setting of the mayoral reception in Karlsruhe—with little speech but beautiful music—followed by the luncheon in the Festhalle, will long be remembered. There was much of interest also in the illuminated streets of Berlin, Baden, and Karlsruhe. To these and other features of the conference we shall make fuller reference.

In conclusion, it should be emphasised that, despite the delightful setting of the visit, much serious work was done, reports and resolutions on fourteen different topics, the result of much previous investigation, being handled. Amongst the subjects discussed were Factory and School Lighting, Architectural Lighting, Lighting Practice, Street Lighting, Traffic Control Signals, Coloured Glasses for Signals, Automobile Headlights, Glare, Aviation, Photometry and Colorimetry, Diffusing Materials, and Ultra-Violet Light.

This country was well represented, and one was glad to see that the work of the Hon. Secretary (Mr. C. C. Paterson) and of the Central Bureau, under the charge of Mr. J. S. Preston, of the National Physical Laboratory, received well-merited recognition.

At the conclusion of the meetings Professor Charles Fabry was invited to be the next President, and it was agreed that the Tenth Session should be held in Holland in 1938.

Factory Lighting

Some Notes on the Annual Report of the
Chief Inspector of Factories and Workshops
for the Year 1934.

The Annual Report of the Chief Inspector of Factories (Mr. D. R. Wilson) as usual contains some informative remarks on lighting in factories and workshops. One gathers that in certain trades, e.g., in the iron industry and to a great extent in the steel tool, cutlery, and silversmiths' trades, unsatisfactory conditions are still very prevalent. In other cases, as in the clothing trades, glare is a common evil. Employers are not usually niggardly in the supply of high-candle-power lamps, but do not seem to understand the necessity for suitable reflectors. In the Sheffield trades the revelations of the 1933-34 inquiry have had a good effect, and steady improvement is recorded. The potential dangers of bad lighting are not confined to eyestrain. Safety may be imperilled, as in the case of the electrician who fell into a

brewery vat of boiling water, left unattended in darkness.

An interesting feature has been the increased consideration paid to the needs of each individual worker, and the introduction of ingenious devices for the lighting of special processes. Considerable advances have been made in lighting the intricate processes in the artificial silk and hosiery works. The application of low-voltage lamps for local lighting is increasing. Such units are specially designed to withstand vibration and have been applied to file-cutting, drill-shaping, sewing, and other machines. A special case is afforded by engraving machines used at thermometer works, intense pools of light from shaded miniature fittings being created. Yet another special problem has been the illumination of work involving the fixing of nuts and bolts in certain small and dark interiors in aeroplane construction. Two methods of meeting the need have been devised, one an arrangement of the screen type giving light from the side and below, the other a system of general floodlighting, giving a minimum illumination of 18 foot-candles.

Literature on Lighting

(Abstracts of Recent Articles on Illumination
and Photometry in the Technical Press)

(Continued from page 237, July, 1935.)

I.—RADIATION AND GENERAL PHYSICS.

220. Attenuation of Light in the Lower Atmosphere.

E. O. Hulber. *J. Opt. Soc. Amer.*, 25, pp. 125-130, May, 1935.

The author draws the following conclusions: (a) From 3,500 to 5,400 Å in distances up to 6 km. the attenuation of pure air and water vapour is due to molecular scattering with negligible true absorption; (b) from 3,000 to 2,000 Å pure air possesses an absorption in addition to molecular scattering, probably due to oxygen, which increases rapidly with decreasing wavelength; (c) the degradation of visible light in normally clear air at sea, probably due to prevalent haze, is such as to reduce light to 1/10 in ten nautical miles; (d) natural fog degrades visible light either equally across the spectrum or slightly less for red than for blue light, but not enough to redden appreciably white or yellow lights. F. J. C. B.

II.—PHOTOMETRY.

221. Note on Names of Photoelectric Devices.

Clayton H. Sharp. *J. Opt. Soc. Amer.*, 25, pp. 165-166, May, 1935.

It is urged that properly distinctive and descriptive names for the various classes of photoelectric devices should be standardised. F. J. C. B.

222. A Co-ordinated System of Optical Filters for Colour-Temperature Determinations.

Frank Benford. *J. Opt. Soc. Amer.*, 25, pp. 136-141, May, 1935.

A set of colour filters with some forty combinations is described, which, when used with a tungsten filament lamp operated at a colour temperature of 2,250° K., gives resultant colour temperatures up to 3,000° K. F. J. C. B.

223. A Filter for Obtaining Light at Wavelength 5,600 Å.U.

Kasson S. Gibson. *J. Opt. Soc. Amer.*, 25, pp. 131-135, May, 1935.

A new four-component glass filter is described which isolates and transmits light at 5,600 Å.U. The spectral transmissions of the components and the complete filter are given. F. J. C. B.

224. Definitions and Properties of the Various Quantities Involved in Reflection of Light.

J. Dourgnon. *R.G.E.*, 37, No. 26, p. 819, June 29, 1935.

An account with diagrams of work done on reflection factors, both regular and diffuse. W. R. S.

III.—SOURCES OF LIGHT.

225. The Spectral Distribution of Radiation from Three Reflector Units.

B. T. Barnes. *J. Opt. Soc. Amer.*, 25, p. 167, June, 1935.

The paper gives the spectral distribution of the energy

radiated in the wavelength range from 2,950 to 27,000 Å for sun-lamps, Types S1 and S2, and also for an infra-red unit. F. J. C. B.

226. Business in Vapour Lamps.

Samuel G. Hibben. *El. World*, 105, p. 1489, June 8, 1935.

Some data are given on the American sodium and mercury vapour discharge lamps, and a discussion of their general application. S. S. B.

IV.—LIGHTING EQUIPMENT.

227. Standard Tests for Enamels: Reflectance.

Anon. *Frank. Inst.*, J., 219, pp. 750-751, June, 1935.
Bur. Stds., Tech. News Bull., 213, January, 1935.

The Bureau of Standards undertook to develop standard tests for enamels, and a tour of American laboratories was made to determine the methods at present in use, and causes of variation between results. The main causes of these discrepancies are stated. It was found that the variation in results was surprisingly small. It is planned to provide reflectance standards, and to eliminate the existing errors. S. S. B.

V.—APPLICATIONS OF LIGHT.

228. Lighting in Europe.

B. Seeger and W. J. Jones. *Elect.*, 114, pp. 828-829, June 21, 1935.

A summary is given of a paper before the German Illuminating Engineering Society dealing with recent progress in lighting in various European countries. C. A. M.

229. Illumination Experts Refuted.

Anon. *Frank. Inst.*, J., 219, p. 777, June, 1935.

The article is an abstract of work done at the University of Minnesota, from which it is deduced that high intensities of general illumination are not essential, and may sometimes be harmful. The values recommended are lower than those generally agreed upon as desirable. S. S. B.

230. Lighting Silk Looms.

J. W. Howell. *El. Rev.*, Vol. CXVI, No. 3,003, p. 864, June 14; No. 3,007, p. 43, July 12, 1935.

The advantages of directional lighting on looms are discussed. The author shows that uni-directional lighting on the looms has the direct effect of improving the quality of the output, and that improved dispersive lighting will show beneficial results. R. G. H.

231. Lighting of Control Rooms.

W. B. Morton. *Elec. Journal*, Vol. 32, No. 6, p. 221, June, 1935.

The article suggests that the lighting of power station

control rooms should be more carefully studied, not only as regards the lighting fittings, but also the type of finish desirable for the different panels.
R. G. H.

232. Industrial Efficiency.

"Works Engineer." *Elect.*, 114, p. 854, June 28, 1935.

A discussion is given on the use in industry of the carbon dioxide luminous discharge tube for processes where slight differences in colour must be detected.
C. A. M.

233. Floodlighting in Industry.

J. B. Harris. *El. Rev.*, Vol. CXVI., No. 3,004, p. 902, June 21, 1935.

The advantages of floodlighting quarries, railway yards, shipyards, and other large spaces where night work is done, are discussed. Suitable positioning of units is suggested, and desirable illumination values given.
R. G. H.

234. Floodlighting for Manhole Construction.

Anon. *Electric Journal*, Vol. 32, No. 5, p. 185, May, 1935.

During rebuilding of manholes on an electrical distribution system, the work was floodlighted from above to promote safety and facilitate operations.
R. G. H.

235. Train Lighting.

Anon., *Elect.*, 114, p. 820, June 21, 1935.

A suggestion is made on the use of hot cathode lamps to be affixed to the rear of trains in order to minimise the risk of head to tail collisions at night.
C. A. M.

236. Street Railways.

H. H. Helmbright. *Light*, 4, No. 3, pp. 24-26, May, 1935.

Constructional details and photometric results are given for experimental trough lighting designed for use in street cars in America.
C. A. M.

237. Albert Embankment Lighting.

Anon. *El. Times*, 87, p. 593, May 2, 1935.

Some notes, with photographs, of electric discharge lamp lighting recently installed along the Albert Embankment, London. Both decorative and utilitarian lighting systems have been installed, and are described.
W. R. S.

238. The Transport Congress.

Anon. *El. Times*, 87, p. 831, June 13, 1935.

A comprehensive report of a paper by Mr. S. J. Patmore, entitled "Lighting as an Aid to Passenger Transport," read at the Transport Congress at Llandudno.
W. R. S.

239. Subterranean Daylight in Cleveland's Exhibition Hall.

Wm. G. Lougee and F. C. Winkler. *Electric Journal*, Vol. 32, No. 5, p. 200, May, 1935.

A dual purpose lighting unit is described for use in an underground space, which is used alternatively as a parking space and as an exhibition hall.
R. G. H.

240. Illumination of L'Ecole Nationale Supérieure des Beaux-Arts.

J. Chappat and R. d'Aboville. *R.G.E.*, 37, p. 711, June 1, 1935.

A description, with photographs, of lighting carried out in connection with the "Week of Light," held in Paris.
W. R. S.

241. Stage Lighting Control by Console.

Anon. *El. Times*, 87, p. 863, June 20, 1935.

Describes a console, resembling that of an organ in appearance, for the easy control of stage and similar lighting.
W. R. S.

242. Garden Lighting.

F. Clayton Albert and C. M. Cutler. *Light*, 4, No. 3, pp. 4-9, May, 1935.

Various garden lighting installations in America are illustrated with numerous photographs. Typical equipment for such installations is discussed in detail.
C. A. M.

243. Garden Lighting.

Anon. *Light*, 4, No. 3, pp. 2-9, May, 1935.

Examples of typical garden lighting schemes are given with recommendations of equipment available for carrying out such schemes.
C. A. M.

244. Tulip Time in Lancashire.

Anon. *El. Times*, 87, p. 873, June 20, 1935.

Photographs and a description of the floodlighting of tulip beds in Blackburn.
W. R. S.

245. Jubilee Floodlighting.

Anon. *El. Times*, 87, pp. 623-626, May 9; pp. 655-657, May 16; p. 699, May 23; p. 737, May 30; p. 829, June 13, 1935.

Photographs and brief accounts of floodlighting installed for the Silver Jubilee Celebrations in London and the Provinces.
W. R. S.

246. Jubilee Floodlighting.

Anon. *Elect.*, 114, pp. 648 and 651, May 17; p. 780, June 7, 1935.

A further collection of photographs of floodlighting schemes in London.
C. A. M.

247. Floodlighting.

Anon. *Elect.*, 114, pp. 735 and 742, June 7; pp. 810 and 816, June 14, 1935.

Photographs are given of various floodlighting installations at Bournemouth.
C. A. M.

248. On a Method of Studying Between-Lens Photographic Shutters.

A. Arnaud and M. Schleeveis. *Rev. d'Optique*, 14, No. 1, p. 1, Jan., 1935.

Describes a method using photographic photometry for studying the speed and action of between-lens shutters, enabling the curve of opening area/time to be plotted and the action of the leaves to be studied.
J. M. W.

N.P.L. Papers

We notice in the most recent list of papers published by the National Physical Laboratory the following two items:—

Brightness difference threshold meter for the evaluation of glare from light sources. By B. H. Crawford, M.Sc., and W. S. Stiles, B.Sc., Ph.D. Published in the *Journal of Scientific Instruments*, Vol. 12, p. 177.

Magnesium oxychloride for photometer screens and test plates. By J. S. Preston, M.A., A.M.I.E.E., F.Inst.P. Published in the *Journal of Scientific Instruments*, Vol. 12, p. 197.

Those interested in the preparation of photometric surfaces will no doubt like to have the reference to Mr. Preston's contribution.

Lighting Service Bureau Touring Demonstration Fixtures

We have received particulars of the fixtures arranged for this touring demonstration during September, which include Newport (September 2-5), Chippenham (September 9-10), Trowbridge (September 12-13), and Adcocks Green, Birmingham (September 23 onwards). In the last-named locality, addresses are to be given to scholars, women's organisations, and shopkeepers.



Recent Patents

(Abstracts of recent Patents on Illumination & Photometry.)

No. 427,835. "Improvements in Electric Light Fittings."

The General Electric Company, Limited, and Randall, E. L., January 19, 1934.

This specification covers a fitting for rigid attachment to a suspension tube through which supply conductors pass, in which a duct is arranged to carry off liquid condensing in the suspension tube away from the terminals of the lamp holder.

No. 428,084. "Improvements in and relating to Electric Discharge Lamps."

The British Thomson-Houston Company, Limited, and Mitchell, J. H., November 8, 1933, February 26, 1934 (Cognate Applications).

This specification covers the maintenance of substantially constant temperature throughout a tubular type vapour discharge lamp, so that the required vapour pressure may be maintained without undue heating of any part, by forming the ends of the lamp tube to a reduced diameter and of conical shape, and mounting an electrode at the apex of each cone. A reflector may also be secured at each cone apex. The metal for the vapour filling may be introduced in the form of a wire through the exhaust tube and vaporised in the lamp after exhaustion and introduction of mercury vapour.

No. 428,387. "Improvements relating to the Projection of Light."

The Edison Swan Electric Company, Limited, and Wheat, H. C., November 13, 1933.

This case covers a pair of projectors of the kind giving a parallel beam from a point source at the focus arranged in proximity, so that their foci nearly coincide but not quite, with a light source adjustably disposed between them. In one form, two truncated parabolic reflectors are placed back to back.

No. 428,498. "Improvements in or Relating to Light Filters for Electric Lamps."

Braune, A., April 17, 1934.

This specification covers a filter with a liquid container constructed as a lens-shaped hollow body which encloses only the lower portion of the electric bulb, and is separated by an air circulation space from an inner evacuated container which is in contact with the lower portion of the bulb, but separated from the upper and middle portion thereof by a second air circulating space. The liquid container may be filled with brine. Also, it may be ring shape or annular, with no bottom.

No. 428,678. "Improvements in Luminous Electric Discharge Tubes."

The General Electric Company, Ltd., April 24, 1934 (Convention, Germany).

According to this specification a luminous tube with a thermionic cathode and rare gas filling has a box-like anode, pierced by one or more slits or holes, and containing a glass envelope filled with vaporizable metal, such as sodium. The glass envelope communicates with the interior of the tube by means of a capillary tube, which extends into the envelope.

No. 428,791. "An Improved Vehicle Head Lamp."

Macleod, H. C., November 29, 1933, and January 30, 1934 (Cognate Applications).

This specification describes a head lamp having a reflector arranged in relation to the light source so

as to direct a light beam forwardly and slightly downwardly through a tier of slats or louvres, which intercept a portion of the beam and reflect it downwards at a steeper angle. The rear edge of each slat or louvre is preferably nearly level with the front edge of that immediately above it. The lamp, as a whole, may be capable of tilting, and the louvres or slats may swivel to prevent any of the beam passing without reflection.

No. 428,813. "Improvements in Incandescent Gas Mantles."

South Metropolitan Gas Company, and Prestage, A. J., October 15, 1934.

This case deals with a gas mantle of non-circular cross section. The mantle has restraining threads of mantle fabric extending from side to side where it is desired that the diameter should not be increased. The mantle may comprise two sheaths, one within the other and of non-circular cross section, and the inner sheath may be provided with restraining threads.

No. 429,030. "Improvements in Electric Discharge Lamps."

The General Electric Company, Ltd., November 19, 1932. (Convention, Germany).

This specification describes a head-lamp for vehicles having a combined discharge and incandescent lamp adapted to operate from a low voltage supply, such as twenty volts or less. The discharge of the lamp passes through the focus of the reflector as a shunt across a loop shaped incandescent filament, of which the ends are disposed symmetrically on opposite sides of the common axis of the lamp and reflector in a plane passing through the focus, and are coated with, or surround and heat bodies coated with, a material of low work function, so that they serve as electrodes for the discharge. The lamp may be filled with sodium vapour to produce a sodium spectrum as well as the light from the filament.

No. 429,340. "Optical Device for Selectively Transmitting Non-Parallel Light Rays."

Cilliers, A. C., August 25, 1933.

This specification deals with an optical device of various application for eliminating from a beam of non-parallel light components divergent by more than a certain amount from a plane containing the beam axis. The device comprises a plate, one part of the thickness of which consists of a series of similar prisms, each having an entry and an emergent face, arranged with their similar faces parallel, the other part of the thickness being spaced from the emergent faces of the prisms and being adapted, as by being prismatic, to recombine as a beam those rays of a beam entering the entry faces of the prisms which emerge from the emergent faces, and a rarer medium than that of the prisms and recombining part separating these parts. The third faces of the prisms are provided with means for intercepting any light issuing therefrom. The recombining part may consist of prisms inverted relatively to and interleaved with those of the decomposing part. The device may be used as a screen for head-lamps, for spectacles, for windows and for other purposes to eliminate glare.



REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

Lighting Calculations.

By Professor H. H. Higbie. (Chapman and Hall, Ltd., London, 1934; pp. 503 + x.)

With the rapid advance of the more scientific and analytical treatment of lighting problems, there is a need to-day for the practical engineer of a handbook which supplies something more than formulae and the mere statement of first principles. Professor Higbie, in this somewhat lengthy work, has undertaken to supply the need and has made a valuable addition to lighting literature. The book covers practically all branches of the art, and so takes in a wide field in the mathematics of illumination, wherein methods of calculation are described and developed from first principles right through to the actual result in working data and formulae. Numerous examples are given, some of which are worked out. The author, however, also adds to each chapter a very large number of problems, such as would doubtless prove useful for the setting of papers in Universities, etc. Their educational value would naturally have been much greater if the working and solutions had been given, though in some instances they contain references to helpful articles and papers. The discussion of calculations of illumination from linear and surface sources of light is timely, in view of interest and important part played by such sources in so-called "architectural lighting." Among other subjects treated are the control of brightness, the author's method of calculating illumination from windows and surface sources of light, and the utilisation of co-efficient. In the first chapter of the book the author seeks to answer the query, "Why bother about Lighting Calculations," though we note that he is also careful to illustrate the point that "good lighting requires other considerations than calculations." In the final chapter on Visual Effectiveness of Lighting he discusses the factors bearing on intensity of illumination required, glare and shadows, and shows that calculations have value even in these fields into which physiological elements enter so greatly.

Encyclopedie Photometrique, Section, Gas extremes. Vol. IV.: Photometrie des Lumieres Breves ou Variables.

By Mme. Marguerite Moreau-Hanot, Editions de la Revue d'Optique Theorique et Instrumentale. (Paris, 1935, 1934; pp. 126).

This work forms part of the general encyclopaedia of photometry now appearing in France, and is concerned with the photometry of lights which are transient or intermittent. Early chapters deal with the physiological side of the problem, i.e., the nature of the response, and the duration of excitation, as illustrated by the "black band" of Charpentier and the curves derived by Broca and Sil Sulzer. The application of this to luminous signals is shown. A subsequent chapter deals with persistence of vision and the Law of Talbot, after which we pass on to the photographic study of lights of short duration and the methods of producing them, such as electric sparks and discharges. Next, the behaviour and use of various forms of photo-electric cells is discussed. Finally, two chapters are devoted to the electric transmission of images, television, and the optical transmission and reproduction of sound. This work forms one of a series of specialised studies of photometry, of considerable interest to the expert. We observe that other sections of the complete encyclopaedia are devoted to such topics as physical and visual photometry, measurements of absorption, reflection and diffusion, and standardised intensities of light as applied in the photographic arts and in phototherapy.

Stage Lighting Principles and Practice.

By C. Harold Ridge and F. S. Aldred. (Sir Isaac Pitman and Sons, Ltd., London, 1935; pp. 130, figs. 86).

The names of the authors will be familiar to readers of this journal. They now seek to do, on a broader scale, what has already been done in connection with "little" theatre. Mr. Herbert Prentice, of the Repertory Theatre, Birmingham, contributes an introduction, in which he denies that the theatre in this country is in a deplorable condition. It would seem, however, that the unsatisfactory condition is merely transferred by him to the public—who are not sufficiently "theatre-minded." There is justice, however, in his plea that, granted that "the play's the thing," we should assume "the play" to include all needful accessories, including the lighting. The twelve chapters furnished by the authors deal in succession with technical terms, electric supply, light, and apparatus, after which planning and design, coloured light, projection of scenery, general principles of lighting, and lighting plots are discussed. The explanations are lucid, and the ground is well covered. The latest advances in dimmers and switchboards, spotlights and floods, cyclorama, etc., are fully illustrated with the aid of original sketches and occasional colour plates. Many of these are excellent. We confess, however, that we are less happy about the practice of using blocks from catalogues, with the names of manufacturers attached, though this might be defended on the ground that it tells readers where to go for fuller information. There is an adequate index and a bibliography. The authors have provided what was previously missing, a book about stage lighting that anyone with a little technical knowledge can understand, and in the first chapter they have not forgotten the needs of the reader who may be well equipped technically but completely ignorant of theatrical terms.

The Old Inns of England.

By A. E. Richardson. (Batsford, Ltd., 1934; pp. 118; plates 132.)

Readers will no doubt excuse a digression from the paths of science and technicalities to notice this interesting work, which contains so many charming illustrations, either from photographs or drawings by Brian Cook, of the old inns of England. Even in these days there are many exteriors of great interest, and agreeably situated, to be found. To readers of this journal, perhaps, the most interesting chapter is that dealing with "Inn Names and Their Lore." The signs recording the many curious names given to taverns go back to classical times. At one time they reached a stage of great elaboration, designs spanning the complete road being known. In the late eighteenth and nineteenth centuries their production was a recognised industry, with its centre at Harp Alley, near Shoe Lane. From early days on, innkeepers were compelled to display a sign. During the Great Fire the majority of old London signs were swept away. When the city was rebuilding, signs of enormous size were in fashion, but, later, a new Act was passed confining them to a size that could be hung in some convenient position, instead of spanning the road. From that time onwards, legislation intended to safeguard the public against possible dangers from overhead signs became usual, and here, doubtless, is the origin of many of the rules and by-laws that perplex the makers of illuminated signs of to-day.



Fig. 1. A View of the Palm Court, Regent Palace Hotel, London. (Architect: F. J. Wills, F.R.I.B.A.)

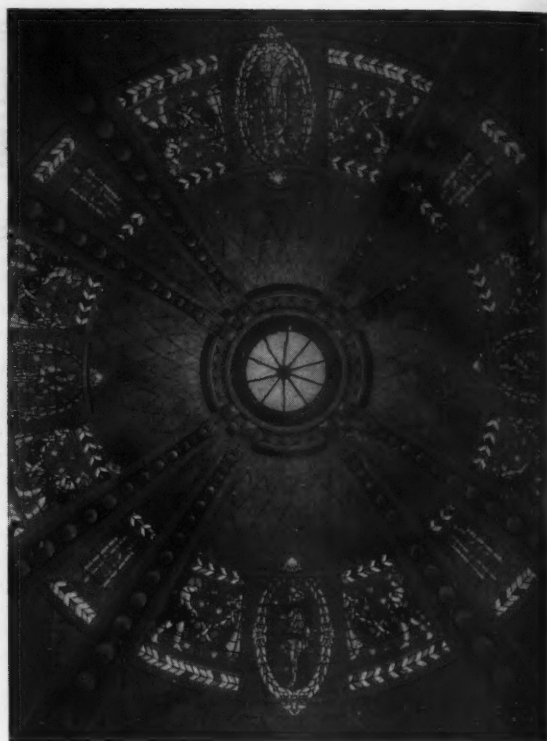


Fig. 2. A Close View of the Illuminated Glass Decorative Band encircling the Dome shown in Fig. 1.

Some Recent Installations of Interest:

IN what follows we give a brief illustrated account of some recent lighting installations, several of which present unusual features or illustrate principles in an interesting way.

The first of these is that well-known rendezvous, the Palm Court at the Regent Palace Hotel (Figs. 1 and 2). It will be noted that the dome seen in Fig. 1 receives illumination from the cornice. Light is also furnished by the central fitting at the apex of the dome. One feature, however, which was not fully revealed until recently, is the band of decorative glass of pleasing design which encircles the dome and is illuminated by transmitted light. A great improvement was recently secured in the method of lighting-up this glass design by the use of G.V.D. fittings. We understand that something like 500 per cent. more light was thus concentrated on the design, although the consumption of electricity was not increased, and actually 75 per cent. fewer lamps were used. The effect of this luminous decoration, which is now fully evident for the first time, is illustrated in Fig. 2. It may be added that the effect of the transmitted light is not spoiled but rather enhanced by the fact that the coloured surface in which the glass is inset is itself illuminated—receives illumination from the cornice. It is, however, necessary that the

requisite extra brightness of the glass should be secured so that the design may stand out well against its illuminated surround, and this the new method of lighting successfully achieves.

Our next illustration (Fig. 3) shows a somewhat unusual type of lighting fitting, installed in the portico of a famous West-End restaurant. This model gondola is approximately 4 ft. long and is correct in detail. It contains two 200-watt lamps. Despite this very moderate current consumption, illumination of ample and even intensity, as illustrated in Fig. 4, is obtained.

In passing our attention has been called to one discrepancy in the Venetian design of this portico, which, we imagine, would have escaped the attention of almost all our readers. Strictly speaking, the spiral on the uprights runs the wrong way, i.e., in the manner characteristic of a barber's pole, instead

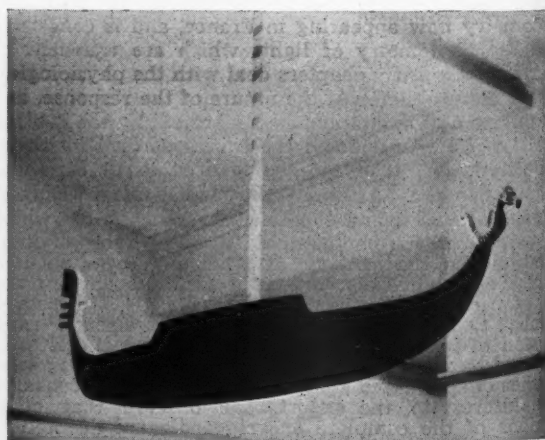


Fig. 3. An original Indirect Lighting Fitting in the form of a Gondola.



Fig. 4. The Portico of the San Marco Restaurant, Mayfair, in which the "gondola" fitting illustrated in Fig. 3 is installed. (Decorations by Oliver Messel.)

of in the converse direction, which is conventional in Venetian decoration.

Fig 5 shows the application of modern methods of lighting in transforming a suite of old chambers into a modern flat. An interesting feature is the provision for both uncorrected and "daylight" artificial illumination. The laylight and the artificial window shown in the picture each incorporate two bulbs, one for artificial daylight and one for ordinary uncorrected light, with independent switches enabling either to be used at will.

In Figs. 6 and 7 we have illustrations of a highly modern method of indirect lighting from cylindrical units mounted on columns. In the case of Fig. 6, which shows a shoe shop in a London suburb, there are only four lamps in each fitting. Yet there is an impression of abundance of light throughout the shop, and entire absence of glare, whilst, for in-



Fig. 6. A Shoe Shop in a London suburb, equipped with indirect lighting from pillars. (Architect: Clive Entwistle, A.R.I.B.A.)



Fig. 5. Old Chambers converted into a Modern Flat with laylight and artificial window, equipped with both daylight and uncorrected artificial lighting. (Architect: Gillian Harrison, F.R.I.B.A.)

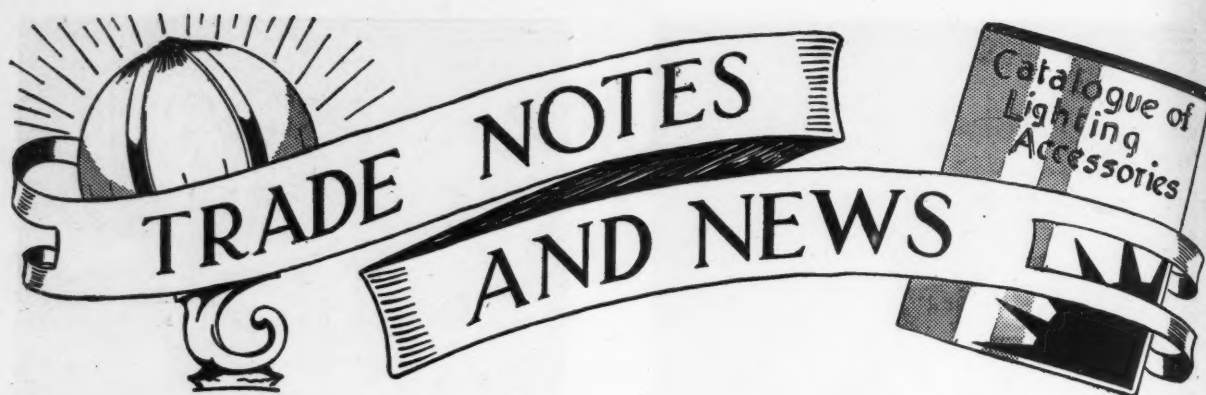
direct lighting, the consumption is distinctly low. This installation should serve to correct the view that the apparent absence of shadows necessarily causes a "dead" effect. In this case there is an air of restfulness but no suggestion of monotony—an effect which is at least partially due to the skilful use of foliage plants to break up the background.

Fig. 7 illustrates the use of similar methods in a millinery showroom, the pillar-fittings being, however, combined with cornice lighting. A feature here is the use of artificial daylight, enabling ladies to select millinery under daylight conditions. Although the lighting is liberal, absence of glare in the mirrors is a feature. The clear reflections have been the subject of favourable comment.

(We are indebted to G.V.D. Illuminators, Ltd., for the illustrations accompanying this note.)



Fig. 7. A West-End Millinery Showroom, illuminated by indirect pillar fittings and cornice lighting. (Architect: Oliver Hill, F.R.I.B.A.)



Silver Jubilee Floodlighting

We have received many congratulations on the illustrated account of the Silver Jubilee Floodlighting in our June issue. It was naturally impossible to describe all the special efforts made on that occasion, even in the London area. There is one section of the lighting industry, however, whose work should not be overlooked—the electrical contractors whose wiring problems were sometimes quite as formidable as those of designers of projectors and other lighting equipment. Our attention is drawn to this point by some data we have received relating to the considerable number of installations in which Messrs. Troughton and Young were interested. Amongst well known buildings handled by them may be mentioned the Athenaeum Club, Broadcasting House, Buckingham Palace and Victoria Memorial, and the Horse Guards. Another building, the floodlighting of which presented special problems was Adelaide House, where a special structure had to be carried out from the second floor balcony in order to accommodate the projectors.



The Bengal Club, Calcutta, illuminated by G.E.C. floodlights and Osram lamps, a pleasing example of floodlighting in the East.

Modern Lighting at the Zoo

Electric discharge lighting has proved serviceable for the outdoor illumination of the Zoological Gardens in Regent's Park (London), which remains open until 11 p.m. on every Thursday during the summer months. There, this latest form of lighting is to be seen in new surroundings, but with very effective results.

The enclosures and ponds are given quite a "fairly-like" appearance, in which the animals appear with added charm. Aquatic bird life in particular makes an even better appearance than in daytime.

The equipment, which consists of Royal "Ediswan" "Escura" electric discharge lamps in six "Sirius" and "Saturn" lanterns, together with fifty projectors, which are equipped with incandescent lamps, has been installed by the Edison Swan Electric Co. Ltd. in collaboration with Mr Davells, the chief engineer to the Zoological Society.

Portable Stage Lighting at Grosvenor House

We hear that the recent cabaret performance at Grosvenor House in connection with the Actors' Benevolent Fund made a sudden demand on the resources of the Strand Electric and Engineering Co. Ltd. A portable lighting equipment consisting of switchboards, dimmers, arcs, and incandescent lamps had to be specially installed to meet the lighting requirements. The equipment was somewhat unusual. The Ice Rink provided the necessary space for the erection of a platform at one end, and from

this a runway was built to the centre rostrum which provided the acting area proper—an arrangement somewhat recalling the methods of the early Greek Theatre, together with a platform open on all sides such as has been a feature of Russian presentations. Fifty-two 1,000 watt floods, and twelve 1,000 watt long throw units, operative in three colours, were suspended above. Other floods and spots were projected from the gallery sides. From the gallery itself ten arc lamps were fixed on stands, and at the end of the gallery the switchboard operator had a full view of the acting area.

Sunco Specialities

A useful catalogue, "Electrical Appliances," has just been issued by the Sun Electrical Co. Ltd. In the present edition, which contains 163 pages, the range of appliances has been considerably increased; hence the dropping of the former title ("Domestic Appliances") in favour of a more general one. Amongst the articles illustrated are electric clocks, storage water heaters and refrigerators, heating, cooking, and other domestic apparatus, vacuum cleaners, domestic water softeners, etc. We notice at the end a section devoted to sources of ultra-violet and infra-red radiation, suitable for domestic use.

Mazda Mercra Lighting at Bournemouth

We note that, in addition to the floodlighting of the Hotel Burlington, Bournemouth, illustrated in our last issue (p. 240), the British Thomson-Houston Company, Ltd., undertook the lighting of Christchurch-road with 400-watt Mazda Mercra lamps, mounted 25 ft. high on the existing tramway standards and spaced 120 ft. apart.

MAZDA MERCRA LIGHTING IS MAKING THESE ROADS SAFER

Important main roads in various parts of the country have been made safer, both for traffic and pedestrians, by the installation of high intensity lighting with Mazda Mercra Lamps in BTH equipment.

Below we refer to recent and important contracts, which together with many earlier ones, and others not yet begun, indicate that where accident-proof lighting and economical operation are the chief considerations, BTH equipment is chosen.

PURLEY AND COULSDON U.D.C.

5 MILES—190 STANDARDS

In conjunction with the County of London Electric Supply Co., Ltd., we are supplying Mazda Mercra Lamps and BTH Diron Lanterns for lighting five miles of Brighton Road and Godstone Road. (In addition, Mazda Gasfilled Lamps are being used for a further 71 miles of secondary street lighting.)

BOROUGH OF LEYTON

5 MILES—184 STANDARDS

Mazda Mercra Lamps and BTH Diron Lanterns are being employed for the lighting of five miles of Lea Bridge Road and Grove Green Road.

**MAZDA
MERCRA**
REGISTERED TRADE MARK
LIGHTING

is installed at KINGSTON, WILLESSEN, ST. PANCAS, BIRMINGHAM, BIRTLEY (Newcastle-on-Tyne), WOLVERHAMPTON, RUGBY, RAWTENSTALL, ST. ANNES, EDLINGTON, CARDIFF, MAIDSTONE, FOLKESTONE, LUTON, HARRATON, HARWICH, HOLYHEAD, HUDDERSFIELD, LEEDS, HALIFAX.

BTH LIGHTING ENGINEERS. BTH Lighting Engineers will be very pleased to collaborate with any Public Authority in the preparation of a scheme for the improvement of highway illumination. This advisory service is given without charge or obligation.

THE BRITISH THOMSON-HOUSTON CO., LTD., CROWN HOUSE, ALDWYCH, W.C.2



What Advertising Can Do

At the recent Advertising Convention several authors emphasised the part that advertising can play in promoting national recovery. Others suggested its application to objects wider than the mere selling of goods. Disappointment was expressed that the Minister of Transport had not appropriated £50,000 for expenditure on an advertising programme to educate users of the roads. It was suggested that nations—seeing that all of them really shrink from war—should advertise peace, an essential condition of prosperity.

Many speakers emphasised the fact that selling capacity has fallen behind productive skill. Large business concerns do habitually advertise. Weakness is most apparent in collective effort, and in the case of the smaller firms who rarely believe firmly in advertising, and often do not understand how publicity can be best applied to their special products. In the world of to-day, with its continual clamour for attention, "Out of sight, out of mind" is more true than ever it was. The lighting industry, one would think, should constitute an ideal field for collective publicity. Yet there are probably, even to-day, many undertakings whose prosperity depends intimately on the demand for artificial light who take little or no share in general efforts to stimulate this demand.

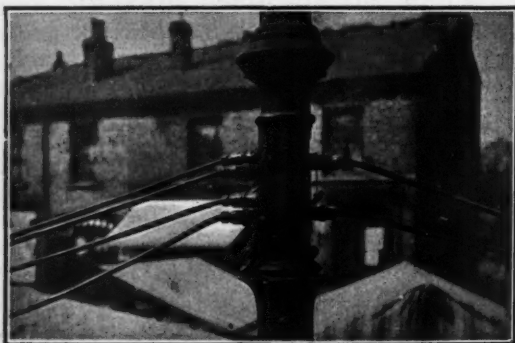
In the case of the small advertiser the opportunities are great, if he will only concentrate on advertising something distinctive—different from what everyone else is offering. We have in mind certain advertisements in this journal which, we were informed, brought inquiries from all over the world—from India, Australia, Russia, and even out-of-the-way spots where we scarcely imagined the journal could have penetrated. Examination showed that in every such case there was something distinctive and arresting about the advertisement, either genuine novelty in the articles offered or descriptive matter so strikingly arranged as inevitably to excite curiosity about them.



Modern Lighting of a Swimming Pool at the Linden Hall Hotel Hydro, Bournemouth illuminated by Osram architectural lamps. (Elec. Contractors, Messrs. Aish and Company.)

Relations With the Netherlands

A "Netherlands and Netherlands Indies Information Bureau" has been established in Shell Mex House, Strand, W.C.2, under the auspices of the Netherlands Government, and in co-operation with the British Chamber of Commerce to provide a means of promoting commercial and other relations between the British Empire and the Netherlands. Included in the executive committee, under the chairmanship of Major the Hon. L. H. Cripps, appears the name of Mr. A. de Jong, Joint Managing Director of Philips Lamps, Limited.



This illustration of part of a "NIPHAN" market lighting installation shows main feeding sockets fitted to a lamp standard. The "NIPHAN" system is adaptable for every type of temporary or portable lighting installation, and designs will gladly be submitted.

MARKET LIGHTING with the NIPHAN System . . .

FOR some years we have been collaborating with public lighting authorities in devising temporary lighting installations for market stalls. The picture shows part of a "NIPHAN" market job, in which 6 sockets, in conjunction with a fuse board, were mounted on a lamp standard, with plugs leading to 3-way tees and suspended through-sockets.

Our extensive market lighting experience is at your disposal.

Announcement of
SIMMONDS & STOKES LTD.,
4, Vernon Place, Southampton Row, London,
W.C.1.

Tel.: Holborn 8637. 'Grams: "Niphan, London."




CRYSELCO LAMPS for every need



OPAL



PEARL



CLEAR



OPAL
TUBULAR



DECORATIVE



SIGN

CRYSELCO LAMPS

Write AT ONCE for new Price List.

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KEMPSTON WORKS, BEDFORD

TELEGRAMS: "CRYSELCO, KEMPSTON, BEDFORD."
TELEPHONES: BEDFORD 3277 & 3278

AND HOME BRANCHES.

■ AUTHENTIC INFORMATION ■

THE ELECTRICAL REVIEW

FOUNDED
1872

The authoritative record of
technical and business news
in the Electrical Industry.

Audited Net Sales
10,587 Copies per week.
EVERY FRIDAY — 6d.

Subscription Rates. Postage Free.

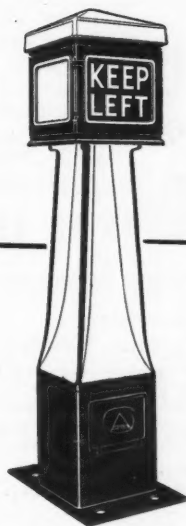
United Kingdom £1 14s. 8d.

Canada £1 12s. 6d.

Colonial and Foreign £2 1s. 6d.

DORSET HOUSE, STAMFORD ST., S.E.1

'Phone: HOP 3333



**For Safety
at Possible
Danger Points**

Experience proves that the erection of the Gowshall White Lady Guard Post at once dangerous points has contributed definitely to safety as well as aiding the flow of traffic. This post is substantially constructed, with cast-iron bollard, vitreous or stove-enamelled, 14-in. lamphouse with one "Keep Left" panel and three panels backed with Vitreolite rippled white glass. Illumination by two 60-watt lamps. Overall height 5 ft. 2 in.

Send for Section 3 of our Catalogue.

GOWSHALL LIMITED,
14/15, LAMBS CONDUIT PASSAGE,
Red Lion Square, London, W.C.1

Telephones:
CHAncery 7042 and 7845.





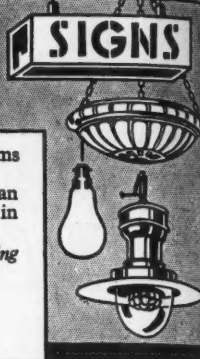
WHERE TO BUY A DIRECTORY OF LIGHTING EQUIPMENT

We invite applications for spaces in this new section of the journal. Particulars of terms for each space (approx. 1 inch deep and 3½ inches wide) are given below.

These terms are equivalent to half our ordinary advertising rates, but not less than 12 successive monthly insertions can be accepted on this basis, and amounts are payable in advance.

Payment for an advertisement in this section entitles the advertiser to receive *The Illuminating Engineer* during the period of the contract.

Terms: 12 Successive Monthly Insertions	£3 10 0	Payable
24 " " "	£6 0 0	in
36 " " "	£8 10 0	Advance



MODERN LIGHTING FITTINGS

New Catalogue on application

Fittings manufactured to Architects' Specifications
ASCOG LIMITED

Ascog House, 44, Theobalds Road, LONDON, W.C.1

PHOTOMETERS

for testing candle-power and illumination. Benches, Cubes, Heads, Standards of Light, Special Fittings and Accessories.

ALEXANDER WRIGHT & CO., LTD.,

1, Westminster Palace Gardens, Artillery Row, Victoria St., London, S.W.1

ALLOM BROTHERS LTD.

16, GROSVENOR PLACE, LONDON, S.W.1.

Specialists in the Science of Modern Lighting, including:
Theatres and Public Halls. Tennis and Racquet Courts.
Pictures and Picture Galleries. Floodlighting, etc.
Decorative Fittings in Glass and Metal.

ELECTRICITY SERVICES LTD.

Sole Proprietors and Patentees of the "ALL PURPOSES"

TYPERLITE LOCAL LIGHTING UNITS

Write for Price Lists: 86, CANNON ST., LONDON, E.C.4
Mansion House 5294 (3 lines)

"ESLA"

BI-MULTI AND MULTIPLANE REFLECTORS
Lanterns, Brackets, Columns, Switch and Fuse Boxes, etc.,
FOR STREET LIGHTING

The Electric Street Lighting Apparatus Co.
The Foundry, Canterbury

ELM WORKS, LTD.

Established 1903

Summerstown, London S.W.17

Suspension Lamps, Lanterns, REFLECTORS
for PUBLIC & INDUSTRIAL LIGHTING

GAS and ELECTRIC

VITREOUS ENAMELLING Sheet Metal Work,
Metal Spinning, &c.



BENJAMIN

PLANNED LIGHTING

THE BENJAMIN ELECTRIC, Ltd., TARIFF ROAD, N.17

You get the benefit of over twenty years' experience in the science of Commercial & Industrial Illumination when you specify Benjamin.

EXPRESS - EUSTON!

For Domestic and Artistic Lighting Fittings

TEL: 2255 EUS.

EUSTON

GRAMS: EUMANCOL, NORWEST, LONDON.

143b, EUSTON ROAD, LONDON, N.W.1.



BROMFORD

Seamless Steel Lighting Standards

for all requirements

BROMFORD TUBE CO., LTD., ASTON, BIRMINGHAM

INDUSTRIAL LIGHTING SPECIALISTS

Cast Iron Columns

Fuses

Time-Switches



Street Lanterns

Winches

Contact Gears

ENGINEERING & LIGHTING EQUIPMENT COMPANY LTD., ST. ALBANS, HERTS.

THE REINFORCED CONCRETE LAMP COLUMNS SPECIALISTS.
CONCRETE UTILITIES, Ltd.
WARE, Herts.



DAWSON REFLECTORS

Indoor and Outdoor Floodlights

JENA REFLECTOR FITTINGS

Miss E. H. DAWSON & HENCKEL,

42, Gray's Inn Road, London, W.C.1.

Telephone: Chancery 8801.

Specialists in

ARCHITECTURAL ILLUMINATION AND DESIGNS

DRAKE & GORHAM LTD.

36, GROSVENOR GARDENS, LONDON, S.W.1

Manchester, Glasgow, Hereford and Winchester.

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BENCH, CUBE and PORTABLE TYPES

employing light sensitive

PHOTO-ELECTRIC CELLS

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HENDON, N.W.9

FARADAY HOUSE TESTING LABORATORIES

All kinds of Lamps, Reflectors, etc., Tested
LAMPS TESTED TO B.S.S. No. 161, 1934

SCALE OF FEES ON APPLICATION TO THE SUPERINTENDENT

66, SOUTHAMPTON ROW, W.C.1



FLOODLIGHTING & FITTINGS

LTD.

294, GRAY'S INN ROAD, W.C.1

Manufacturers of "FLOOD" Units
Specialists in Modern Lighting Fittings
Telephone: TERMINUS 5954.

500/1000
Watts

Model "B"

FOSTER & PULLEN Ltd.

make all types of Lanterns for Street Lighting
BY GAS

Samples for trial willingly sent—we invite comparison on
both cost and quality

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MINISTRY OF TRANSPORT
ILLUMINATED ROAD SIGNS AND
GUARDIAN ANGEL GUARD POSTS
LAMP COLUMNS, ETC.

Gowshall Ltd., 49, Theobald's Road, London, W.C.1

PIONEERS of AUTOMATIC LIGHTING

GAS CONTROLLERS, ELECTRIC, and
SYNCHRONOUS TIME SWITCHES

Manufactured by:—

BRITISH, FOREIGN AND COLONIAL AUTOMATIC LIGHT
CONTROLLING CO., LTD., BOURNEMOUTH.

CONTROLLED LIGHT

Laylights, Cornice
and Pillar Lighting.

G.V.D.

Pendant Fittings
and Standards.

ILLUMINATORS, LTD.

ALDWYCH HOUSE, LONDON, W.C.2.

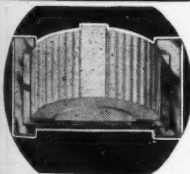
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BRITISH MADE ILLUMINATING GLASSWARE AND FITTINGS,
TRAFFIC GLOBES AND SIGNS, ISLAND COLUMNS AND FOOTLIGHTS.

HAILWOOD & ACKROYD, Ltd.
BEACON WORKS, MORLEY, Near LEEDS.

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Carlton Chambers, 28, High St., Birmingham. [Glasgow.
Ulster Agents: Messrs. Bell & Hull, 17, College Street, Belfast.



Electric Light fittings designed to
suit Architectural requirements
Write for Catalogue No. H.L.103

Harcourts

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Telephone: Museum 8732/3/4

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(Scientific Illumination)

ELVERTON ST., LONDON, S.W.

STREET
CINEMACHURCH
FLOODINDUSTRIAL
SCHOOL, Etc.**KANDEM**

ELECTRICAL LTD.
711 FULHAM RD.
LONDON, S.W.6.

EQUIPMENT

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INDUSTRIAL, COMMERCIAL,
STREET AND RAILWAY LIGHTING,
FILM STUDIOS,
PHOTOGRAPHY, PRINTING, ETC.,
—SUPERIOR QUALITY
AND DESIGN—



UP TO DATE
Street Lighting Equipment

G. H. KEMPTON & CO., Ltd.,
Stangate House, 235, Westminster
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LINOLITE

THE ARCHITECTURAL STRIP. (Regd.)

London Electric Firm Guaranteed

Winches, Lamp Lower-
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Searchlights (largest and
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Mirrors, Lenses,
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metal), Wire Ropes,
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Street Lamps, Poles,
Reduction Gears,
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Cable Drums,
Guide Pulleys,
Electric Irons,
Kettles, Fires,
etc., etc.

On War Office, Admiralty Air Ministry, Post Office, etc., etc., Lists.



MEKELITE
FOR CLOSE-UP LIGHTING
ADJUSTABLE FITTINGS FOR
EVERY USE.

MEK-ELEK ENGINEERING LTD.,
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Floor Standards,
Ceiling
Pendants,
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Corner
Brackets

MONOLAMP

Modern Indirect Fittings

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TELEPHONE: LANG. 2817.

GOLD MEDAL—PARIS, 1931.

Silver Glass
Reflectors
and
Metal
Spinnings

W. PARKINSON & CO

PROMOTERS OF SCIENTIFIC
STREET LIGHTING BY GAS

Our Research Lighting Bureau will solve your problems
IRON LANE STECHFORD BIRMINGHAM
Tel. No.: Stechford 2256. And at London and Belfast

RADIOVISOR PARENT LTD.

28, LITTLE RUSSELL STREET, LONDON, W.C.1

Specialists in Light Actuated Apparatus

AUTOMATIC CONTROL OF STREET and FACTORY LIGHTING
No maintenance costs—Applicable to both A.C. and D.C. Supplies
Phone: Holborn 2986



38-39, UPPER THAMES STREET, LONDON, E.C.4

ELECTRIC LAMPS of all types. ELECTRIC LIGHT FITTINGS.
FLOODLIGHTING APPARATUS. SHOP-WINDOW LIGHTING
EQUIPMENT. STORE LIGHTING. INDUSTRIAL LIGHTING.
CINEMA LIGHTING, ELECTRIC SIGNS, Etc.



PLUGS, SOCKETS, TEES, COUPLINGS,
TERMINAL SOCKETS AND JOINT BOXES
for every portable and temporary
lighting requirement.

SIMMONDS & STOKES, LTD.

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Phones: (Head Office) Holborn 8637; (Works) Putney 1364

PHOTO-ELECTRIC CELLS

Selenium Layer Type (Brit. Pat.) round or square,
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STAFFORD & LESLIE,

ARMOUR HOUSE, ST. MARTIN'S-LE-GRAND, LONDON, E.C.1
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STRAIGHT-LITE REFLECTORS, LTD.,

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ALL OUR FITTINGS CAN BE WIRED READY FOR
ALTERNATE SWITCHING AND SUPPLIED ANODISED
FINISH IN ALL COLOURS, CHROMIUM PLATE OR
COLOUR SPRAY.

Write for Details.

Phone: Canonbury 2066.

37

STRAND ELECTRIC
AND ENGINEERING CO., LTD.
19-24, FLORAL STREET, LONDON, W.C.2
Specialists in Modern Theatrical Lighting
Manufacturers of "Sunray" Lighting Equipment
Electrical Installation Contractors. Lighting Schemes for
Theatres Floodlighting Exhibitions Cinemas Pageants
Shop Windows Dress Parades Ballrooms Tea Lounges

38

For every
type of
GAS LIGHTING



When you
want
the best!
CHAPTER ST.
S.W.1

39

ULTRALUX
LIGHTING FITTINGS
TROUGHTON & YOUNG LTD
143 KNIGHTSBRIDGE

WARDLE ENGINEERING Co., Ltd.
OLD TRAFFORD, MANCHESTER

STREET LIGHTING EQUIPMENT. TRAFFIC SIGNALS
PRISMAT BULKHEAD FITTINGS. FLOODLIGHT PROJECTORS
WORKSLITE REFLECTORS. WARDELYTE GLASSWARE



**"PHOTRONIC" Photo-electric
ILLUMINATION METERS**
BY
WESTON

"THE FITTINGS THAT IMPROVE WITH AGE"
WOODFYT
(WOOD ELECTRIC FITTINGS)
10a, NEWMAN STREET, W.1
(Museum 7325)
Catalogue sent on application

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Contracts Closed

THE BRITISH THOMSON-HOUSTON COMPANY, LTD.
The Air Ministry—For the supply of Mazda lamps for the ten months ending April, 1936, for their R.A.F. commands in the Inland Area, Coastal Area, and Cranwell.

THE EDISON SWAN ELECTRIC COMPANY, LTD.
Royal Mail Lines, Ltd.—For the supply of a por-

tion of their requirements of electric lamps for the twelve months commencing July 1, 1935.
SIEMENS ELECTRIC LAMPS AND SUPPLIES, LTD.
The Air Ministry—For Siemens electric lamps of various types during the next ten months.

MESSRS. P. E. CHAPPUIS & Co., Daylight and Electric Light Reflector Manufacturers, state that, in consequence of the death of their Principal, Mr. William C. Wise, who for over 40 years was the sole proprietor, the business is now transferred to his son, Mr. W. Chas. Wise, who for a number of years has acted for his father as Manager in full control.

SIMPLEX

Industrial, Street Lighting
Commercial & Shopwindow

**REFLECTOR
FITTINGS**



SCIENTIFICALLY DESIGNED
SIMPLEX ELECTRIC CO., LTD.
Head Office: 159, GREAT CHARLES STREET, BIRMINGHAM, 3

"LUX"
(La Revue de l' Eclairage)

WE have pleasure in announcing to our readers that we have entered into an arrangement to receive subscriptions for the French Journal "Lux" (La Revue de l' Eclairage). The subscription per annum is 30 francs, the approximate equivalent of which in English money is Seven Shillings and Six Pence (7/6).

"Lux" is the only French journal which specialises in all aspects of lighting; it is the official organ of the Association Francaise des Ingenieurs de l' Eclairage (equivalent to the Illuminating Engineering Society in France).

It furnishes a complete record of interesting developments in lighting in France and on the Continent. It is fully illustrated and in particular devotes a considerable number of its pages to Decorative Lighting.

By studying these articles and the numerous photographic reproductions of modern lighting installations the reader can readily gain an excellent impression of French methods and practice in matters of Illumination.

Applications for subscriptions will be received by "The Illuminating Engineer," 32, Victoria Street, London, S.W.1.

1935

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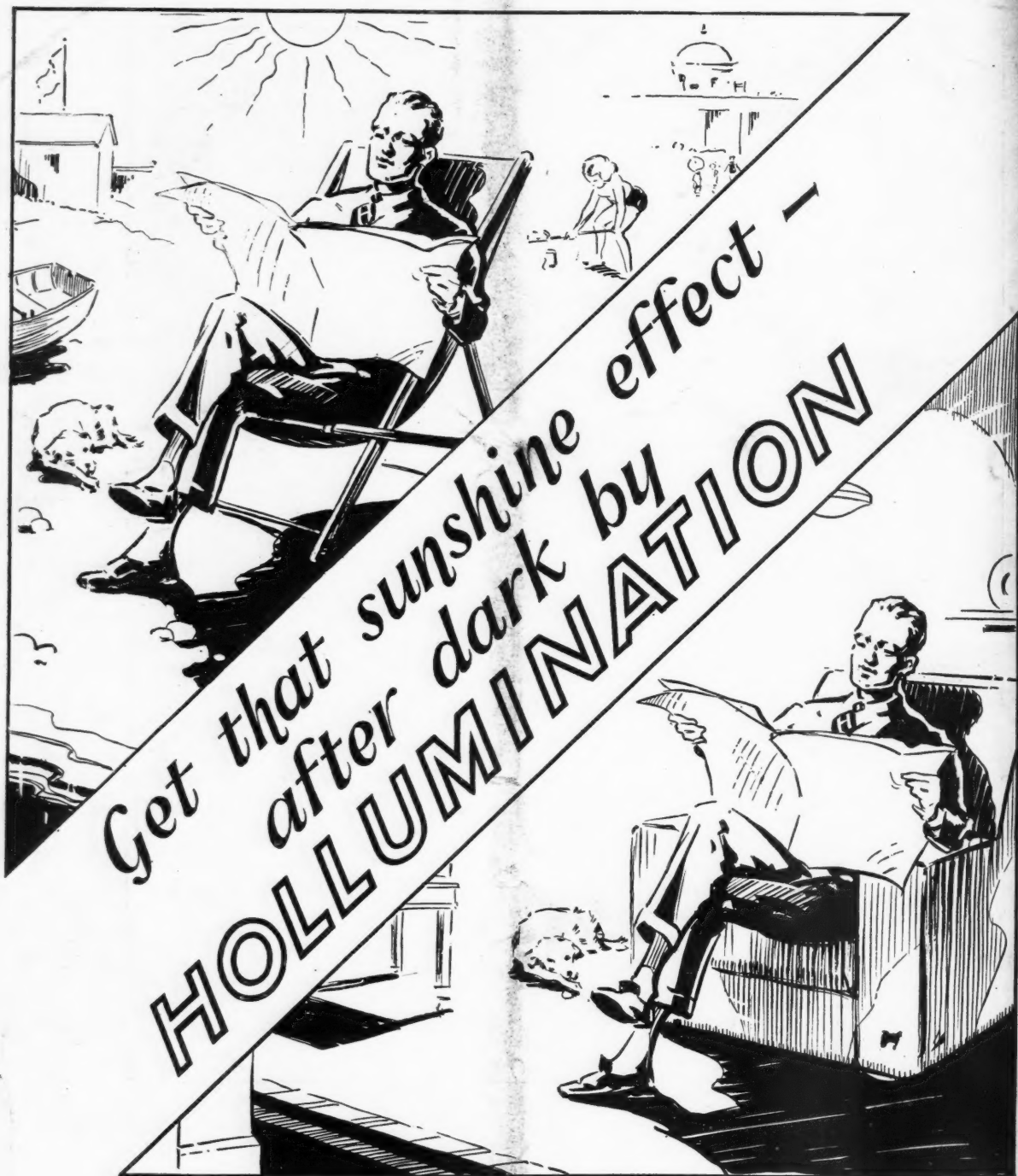
ALL Northampton's Streets are up-to-date with GAS

This illustration gives some idea of the very even spread of light over the roadway, typical of all Northampton. Note the gas illuminated "Keep Left" bollard.

Gas has been chosen because it is **SAFE**. Motorists find it easy on the eyes. Its fog-piercing qualities are valuable. It is cheap. Moreover—**GAS NEVER FAILS!**

Please write to the address below for the FREE booklet, "To every public man and woman." You will find in it many new facts to interest you about public lighting

ISSUED BY THE BRITISH COMMERCIAL GAS ASSOCIATION, 28, GROSVENOR GARDENS, LONDON, S.W.1



HOLOPHANE ILLUMINATION

is the system of SCIENTIFIC LIGHTING that gives to night the uniform brilliance of Solar daylight.

Get that invigorating effect of brilliant lighting by a Holophane scheme for your next installation.

Write for details of modern built-in units to:

HOLOPHANE LTD.

'Grams: Holophane, Sowest, London.

1 Elverton Street,
Vincent Square, London, S.W.1.

'Phone: Victoria 8062 (3 lines)

